













# 中國古生物誌

總號第138冊

新乙種第5號

## 中國樹形筆石

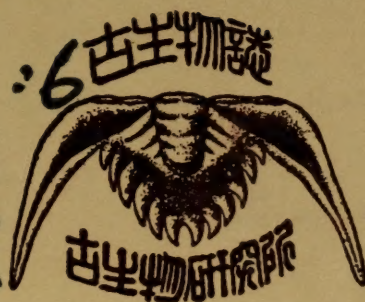
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編輯委員會

李四光 楊鍾健 斯行健 孫雲鑄  
尹贊勳 俞建章 陳 旭

## 中國樹形筆石

穆 恩 之

(中國科學院古生物研究所)

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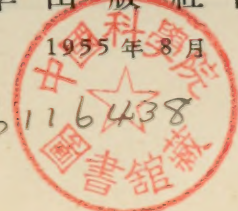
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石 恩 著

(中國科學院古生物研究所古脊椎動物研究室)

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著 者 穆 恩 之

編輯者 中國科學院古生物研究所  
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# 中國樹形筆石

## 一. 引言

中國樹形筆石的研究已有 20 餘年的歷史, 孫雲鑄教授 (1933, 1935)、尹贊勳教授 (1937) 和許傑教授 (1948) 曾經先後描述過一些重要的種族, 包括三個網筆石 (*Dictyonema*)、兩個絞結筆石 (*Desmograptus*)、兩個無羽筆石 (*Callograptus*)、三個樹筆石 (*Dendrograptus*) 及八個刺筆石 (*Acanthograptus*)。所有這些樹形筆石全是下奧陶紀 (包括 *Tremadocian* 及 *Arenigian*) 的產物, 分別採自河北、湖北、江西及雲南等省。近幾年來在許多地方的不同地層裏發現了很多樹形筆石, 如遼寧、山西、內蒙、西康、四川、貴州及浙江等省的上寒武紀、下奧陶紀、中奧陶紀以及下志留紀的地層裏均有發現。這些樹形筆石當中僅有少數幾種曾經由筆者 (1953) 簡略地介紹過。所有這些新的樹形筆石材料包括 15 屬 56 種族統在本文中描述。並對中國樹形筆石的一般情況及其在各個不同地區之間的比較, 予以簡略討論。茲將這些筆石依照產地分別列其名單如下:

(一) 東北遼寧太子河流域 上寒武紀鳳山統及特馬豆克期治里統中的樹形筆石。王鈺、盧衍豪、楊敬之、盛金章及筆者採集。

- |  |  |
|--|--|
| <i>Dictyonema flabelliforme</i> var. <i>liaotungense</i> Mu, | <i>D. liaotungensis</i> Mu (新種)        |
| <i>D. flexiliramosum</i> Mu (新種)                             | <i>D. odontocauloides</i> Mu           |
| <i>D. uniforme</i> Mu  | <i>D. ptilograptoides</i> Mu           |
| <i>D. wutingshanense</i> Mu (新種)                             | <i>D. sinensis</i> Mu                  |
| <i>D. sp. B</i>  | <i>D. suni</i> Mu (新種)                 |
| <i>D. spp. indet.</i>  | <i>D. y-wangi</i> Mu (新種)              |
| <i>Reticulograptus yangi</i> Mu (新種)                         | <i>D. sp.</i>                          |
| <i>Callograptus curvithecalis</i> Mu (新種)                    | <i>Anisograptus lui</i> Mu             |
| <i>C. sinicus</i> Mu (新種)                                    | <i>Bryograptus yentaiensis</i> Mu (新種) |
| <i>C. sp. aff. C. hopkinsoni</i> Bulman                      | <i>B.? shengi</i> Mu (新種)              |
| <i>C.? taitzehoensis</i> Mu                                  | <i>Inocaulis sinensis</i> Mu (新種)      |
| <i>C.? taitzehoensis</i> var. <i>minor</i> Mu (新變種)          | <i>I.? sp. A.</i>                      |
| <i>Airograptus sp. aff. A. furciferus</i> Ruedemann          | <i>I.? sp. B.</i>                      |
| <i>Dendrograptus lotalatzensis</i> Mu (新種)                   |  |

(二) 山西西部與內蒙古之間的黃河峽區 上寒武紀鳳山統及特馬豆克期治里統中的樹形筆石。賈福海、高存禮採集。

- Dictyonema sp. A.*  
*Callograptus staufferi* Ruedemann  
*Dendrograptus sp. indet.*

(三) 湖北西部長陽縣境 下奧陶紀 (特馬豆克後期) 宜昌統上部的樹形筆石。楊敬之及筆者採集。

*Dictyonema asiaticum* Hsü

*Desmograptus* sp.

*Callograptus yangtzensis* Mu (新種)

*Aspidograptus* sp.

*Dendrograptus hsüi* Mu (新種)

*D. hupehensis* Mu (新種)

*D. yangtzensis* Mu (新種)

*D. yini* Mu (新種)

*D. yini* var.  $\alpha$

*D. yini* var.  $\beta$

*Acanthograptus bifurcus* Hsü

*A. flexilis* Mu (新種)

*A. flexiramiatus* Hsü

*A. intermedius* Mu (新種)

*A. macilentus* Hsü

*A. rigidus* Hsü

*A. sinensis* Hsü

*Coremagraptus?* sp.

(四) 四川中部華蓥山 中奧陶紀艾家山統中的樹形筆石。盧衍豪採。

*Dictyonema szechuanense* Mu (新種)

*Ptilograptus glomeratus* var. *sinicus* Mu (新變種)

(五) 貴州北部湄潭縣境 中奧陶紀艾家山統中的樹形筆石。盛莘夫採。

*Dictyonema* sp. C.

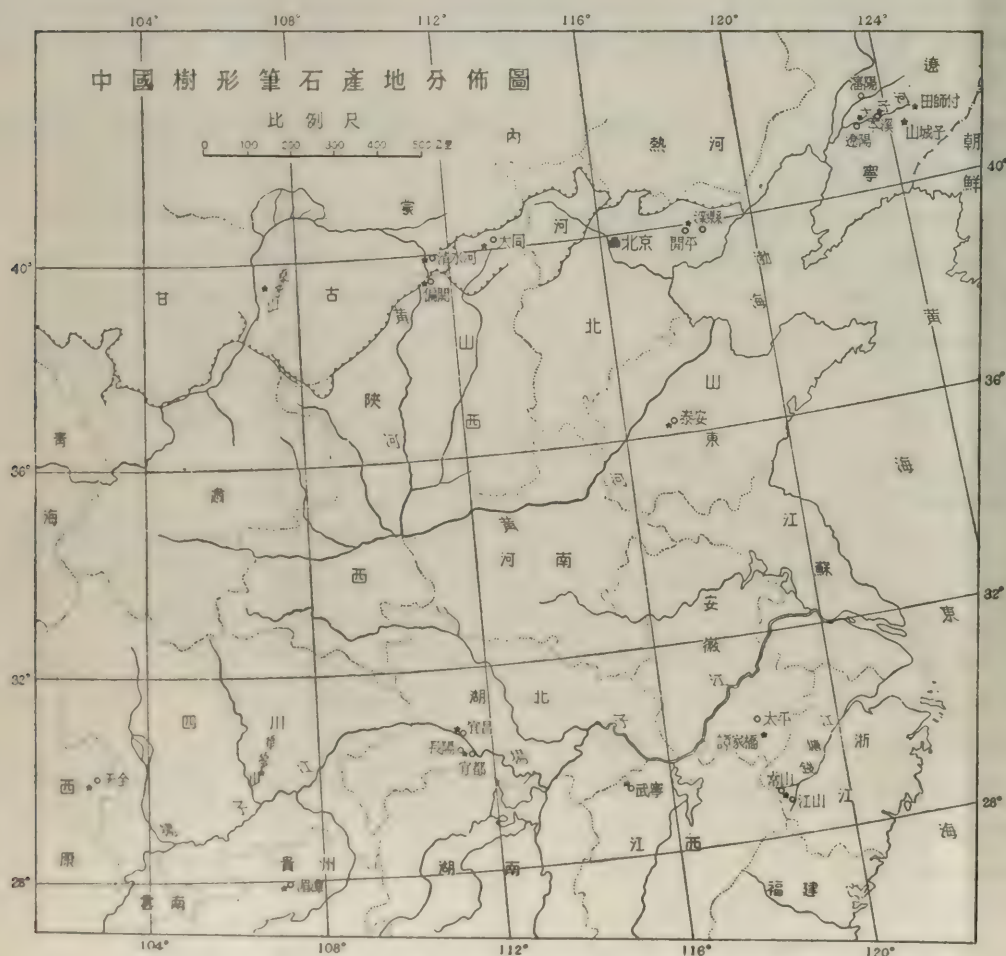


圖 1 示中國樹形筆石的地理分佈。圖中星號指樹形筆石的產地。內蒙古桌子山最近發現的樹形筆石材料未在本文內描述。山東泰安上寒武紀筆石的一個筆石枝 *Clonograptus? cambria* Sun 可能是樹形筆石。在此圖範圍以外的雲南西部保山縣境也產樹形筆石。



(六) 西康東部天全縣境 下志留紀龍馬溪頁岩中的樹形筆石。 程裕淇等採集。

*Dictyonema* sp. aff. *D. delicatulum* Lapworth

(七) 浙江西部江山、常山一帶 特馬豆克期印渚埠頁岩中的樹形筆石。 盧衍豪、侯祐堂、張日東、劉第壩及筆者採集。

*Anisograptus* cf. *matanensis* var. *tetragraptoides* Bulman

*Bryograptus chekiangensis* Mu (新種)

*Adelograptus asiaticus* Mu (新種)

*A. sinicus* Mu (新種)

*Clonograptus tenellus* var. *calavei* Elles et Wood

## 二. 中國樹形筆石的地質分佈表

樹 筆 石 科 網 筆 石 亞 科	上 寒 武 紀	下 奧 陶 紀		中 奧 陶 紀	上 奧 陶 紀	下 志 留 紀
		初 期	後 期			
<i>Dictyonema</i> (網筆石)						
<i>D. asiaticum</i> Hsü .....		+				
<i>D. flabelliforme liaotungense</i> Mu.....		+				
<i>D. flabelliforme orientale</i> Sun .....		+				
<i>D. flexiliramosum</i> Mu .....		+				
<i>D. széchuanense</i> Mu .....				+		
<i>D. uniforme</i> Mu.....		+				
<i>D. wutingshanense</i> Mu.....	+					
<i>D. sp. aff. delicatulum</i> Lapworth.....						+
<i>D. sp. Yin</i> .....			+			
<i>D. sp. A.</i> .....	+					
<i>D. sp. B.</i> .....		+				
<i>D. sp. C.</i> .....				+		
<i>D. sp. indet</i> .....		+				
<i>Reticulograptus</i> (交織筆石)						
<i>R. yangi</i> Mu.....		+				
<i>Desmograptus</i> (絞結筆石)						
<i>D. yehliensis</i> Sun .....		+				
<i>D. sp. Yin</i> .....			+			
<i>D. sp.</i> .....		+				
無羽筆石亞科						
<i>Airograptus</i> (持握筆石)						
<i>A. sp. aff. A. furciferus</i> Ruedemann ...		+				
<i>Aspidograptus</i> (盾筆石)						
<i>A. sp.</i> .....		+				
<i>Callograptus</i> (無羽筆石)						
<i>C. bulmani</i> Sun .....		+				
<i>C. curvithecalis</i> Mu .....		+				
<i>C. sp. aff. hopkinsoni</i> Bulman .....		+				

<i>C. salteri</i> Hall .....	+	?				
<i>C. sinicus</i> Mu .....	+					
<i>C. staufferi</i> Ruedemann .....	+					
<i>C. yangtzensis</i> Mu .....	+					
<i>C.?</i> <i>taitzeensis</i> Mu .....	+					
<i>C.?</i> <i>taitzeensis minor</i> Mu .....	+					
樹筆石亞科						
<i>Dendrograptus</i> (樹筆石)						
<i>D. grabaui</i> Sun .....	+					
<i>D. hsüi</i> Mu .....	+					
<i>D. hupehensis</i> Mu .....	+					
<i>D. irregulis</i> Sun .....	+					
<i>D. liaotungensis</i> Mu .....	+					
<i>D. lotolatzensis</i> Mu .....	+					
<i>D. odontocauloides</i> Mu .....	+					
<i>D. ptilograptoides</i> Mu .....	+					
<i>D. sinensis</i> Mu .....	+					
<i>D. suni</i> Mu .....	+					
<i>D. yini</i> Mu .....	+					
<i>D. yini</i> var. $\alpha$ .....	+					
<i>D. yini</i> var. $\beta$ .....	+					
<i>D. y-wangi</i> Mu .....	+					
<i>D. sp.</i> .....	+					
<i>Ptilograptus</i> (羽筆石)						
<i>P. glomeratus sinicus</i> Mu .....					+	
刺筆石科						
<i>Acanthograptus</i> (刺筆石)						
<i>A. bifurcus</i> Hsü .....	+					
<i>A. erectoramosus</i> Hsü .....	+					
<i>A. flexilis</i> Mu .....	+					
<i>A. flexiramiatus</i> Hsü .....	+					
<i>A. intermedius</i> Mu .....	+					
<i>A. kaoi</i> Sun .....	+					
<i>A. macilentus</i> Hsü .....	+					
<i>A. rigidus</i> Hsü .....	+					
<i>A. sinensis</i> Hsü .....	+					
<i>A. sinensis fenhsiangensis</i> Hsü .....	+					
<i>A. sinensis ituensis</i> Hsü .....	+					
<i>Coremagraptus</i> (帶筆石)						
<i>C.?</i> <i>sp.</i> .....	+					
毛莖筆石科						
<i>Inocaulis</i> (毛莖筆石)						
<i>I. sinensis</i> Mu .....	+					



<i>I.?</i> sp. A. ....	.....	+				
<i>I.?</i> sp. B. ....	.....	+				
反稱筆石科						
<i>Anisograptus</i> (反稱筆石)						
<i>A. lui</i> Mu .....	.....	+				
<i>A. cf. metanensis tetragraptoides</i> Bulman .....	.....	+				
<i>Bryograptus</i> (苔蘚筆石)						
<i>B. chekiangensis</i> Mu .....	.....	+				
<i>B. yentaiensis</i> Mu .....	.....	+				
<i>B.?</i> <i>shengi</i> Mu .....	.....	+				
<i>Adelograptus</i> (匿筆石)						
<i>A. asiaticus</i> Mu .....	.....	+				
<i>A. sinicus</i> Mu .....	.....	+				
<i>Clonograptus</i> (枝筆石)						
<i>C. tenellus calavei</i> E. et W. ....	.....	+				

### 三. 中國樹形筆石動物羣的一般論述

從上面所列舉的化石名單，可以看出中國的樹形筆石大多是東方特有的種族，僅有少數是其他各洲已經發現過的。*Dictyonema flabelliforme* Eichwald (廣義的) 及 *Callograptus salteri* Hall 的地理分佈範圍最廣，亞、歐、美各洲均有發現，是具有世界性的種族。*Callograptus staufferi* Ruedemann 以前僅在北美洲的上寒武紀地層中出現過，現在在中國北方的上寒武紀地層中也找到此種筆石。*Anisograptus matanensis* var. *tetragraptoides* Bulman 是加拿大奎必克 Matane 頁岩 (特馬豆克期) 中發現過的種族，在中國浙江印渚埠頁岩中也找到類似此一變種的筆石。*Clonograptus tenellus* var. *calavei* Elles et Wood 是歐洲特馬豆克期的標準化石之一，也在印渚埠頁岩中出現；以前在皖南譚家橋頁岩中也有此種筆石的報道。*Ptilograptus glomeratus* Pošta 是捷克波希米亞中奧陶紀的產物，中國中奧陶紀艾家山統產出此種筆石的一個變種。

在本文所討論的這些樹形筆石新材料當中，有些標本保存得非常完美，筆石體始部的構造及胞管的形狀都可以清楚地觀察出來。這些性質對於樹形筆石的生態及形態上都是相當重要的。中國上寒武紀的一種網筆石 *Dictyonema wutingshanense* Mu (新種)，具有顯著的胎胞管 (sacula) 和浮盤，表示着這種原始的筆石是浮游生長的。同樣，所有特馬豆克期反稱筆石科 (*Anisograptidae*) 中的筆石，如反稱筆石 (*Anisograptus*)、苔蘚筆石 (*Bryograptus*)、匿筆石 (*Adelograptus*)、枝筆石 (*Clonograptus*) 等都是具有顯著的胎胞管而無莖根等構造，都應當是浮游的生物。有趣的是下志留紀龍馬溪頁岩中的一種網筆石 *Dictyonema* sp. aff. *delicatulum* Lapworth，雖然保存得不完整，胎胞管的性質不能得知，但是，按照它生活的環境及其共生的筆石看來，也應當是浮游的。這種筆石保存在標準的黑色筆石頁岩裏，和它共生的全是浮游的正筆石，而無其他生物。這種黑色頁岩沉積的環境是水流不暢，還原作用很強的海底，在這種情況之下，海底生物不能生存，必須是飄浮在水面的。因此，這一種筆石不可能是棲居海底的。

在另一方面，*Callograptus sinicus* Mu (新種) 具有明顯的莖及附着盤，說明這種筆石是棲居在海底的。同樣情形，在一些樹筆石 (*Dendrograptus*) 中如 *Dendrograptus lotolatzensis* Mu (新種)、*D. liaotungensis* Mu (新種)、*D. odontocauloides* Mu 等都有莖和附着盤；可以相信這些筆石也是在海底生活的。

在一些黃鐵礦化了的筆石標本裏，胞管的形狀很清楚。正胞管有三種不同的形狀：(1) 有的是簡單的直管，在筆石枝的側面看來呈鋸齒狀。這種情形最普通，在我們的標本裏絕大多數的樹形筆石的正胞管都是這樣的，(2) 有的是孤立的管狀，如 *Callograptus yangtzensis* Mu (新種)，(3) 還有的是帶有口刺的，如 *Dictyonema asiaticum* Hsü, *D. szechuanense* Mu (新種)，及 *Airograptus* sp. aff. *A. furciferus* Ruedemann 等。副胞管的形狀也是各有不同：(1) 在許多種族裏，副胞管為簡單的直管狀：(2) 有的是稍微彎曲的，如 *Callograptus sinicus* Mu (新種)；(3) 還有的是呈彎鉤狀的，即副胞管開口於生出方面的對面，並且向後彎曲；如 *Callograptus curvithecalis* Mu (新種)。據 Bulman 的意見，樹形筆石的正胞管口部向內轉曲的現象，可能是和正筆石的胞管向內轉曲的現象相似的（見 Bulman, 1926, 頁 48—49）。向後彎曲如鉤的副胞管以前在比較原始的筆石裏尚不多見，現在我們的新材料證明了在特馬豆克期的樹形筆石如 *Callograptus curvithecalis* 其副胞管已經達到變形的最後階段，即屬於 Bulman 的 *Dictyonema falciferum* 式，或 *Dictyonema inconstans* 式（見插圖 3）。

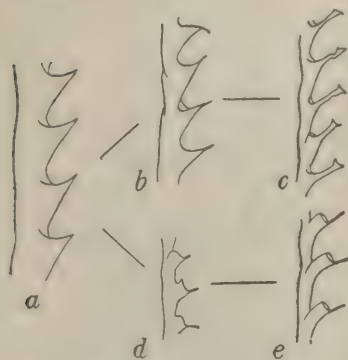


圖 2 示樹形筆石正胞管的幾種類型。根據 Bulman, 1923. a-b-c 示正胞管口刺的發展，a-d-e 示正胞管變向孤立。

從地層上看來，中國的樹形筆石分佈在下面幾個層位：(1) *Dictyonema wulingshanense* Mu (新種)，*D. sp. A*, *Callograptus staufferi* Ruedemann, *Dendrograptus* sp. 等產於上寒武紀鳳山統的 *Quadricephalus* 帶（包括東北鳳山統的 *Dictyonema wulingshanense* 帶在內）。(2) 中國絕大部分樹形筆石都是產在特馬豆克期的地層裏。(3) 僅有兩種樹形筆石，即尹贊勳教授描述過的 *Dictyonema* sp. Yin 和 *Desmograptus* sp. Yin 是產在雲南西部下奧陶紀後期的地層裏，可能是產於 *Didymograptus bifidus* 帶。(4) 值得注意的是艾家山統中的 3 種樹形筆石，即 *Dictyonema szechuanense* Mu (新種) *D. sp. C* 及 *Ptilograptus glomeratus* var. *sinicus* Mu (新變種)，因為在中國中奧陶紀及其以後的地層裏樹形筆石是非常稀少的。在中國上奧陶紀的地層裏雖然正筆石很多，但是直到現在尚未發現一種樹形筆石。(5) 在中國的志留紀地層裏，到現在為止也祇發現過一種樹形筆石，即 *Dictyonema* sp. aff. *D. delicatulum* Lapworth，產於西康天全龍馬溪頁岩下部，可能是 *Monograptus (Demirastrites) convolutus* 帶中。雖然在北美洲和歐洲的泥盆紀及石炭紀地層裏曾經發現過不少樹形筆石，可是，直到現在中國泥盆紀和石炭紀地層裏尚未見到任何樹形筆石。將來由於大規模地質普查的展開，泥盆紀及石炭紀樹形筆石在中國是可能有所發現的。

上面已經提到過，中國的樹形筆石，主要的是產在特馬豆克期的地層裏。就此讓我們將中國特馬豆克期的各個筆石動物羣作一簡單的比較。

大體說來，中國特馬豆克期的樹形筆石可以分作三個不同的筆石動物羣地區：即 (1) 中國北部的開平—太子河區；(2) 中國中部的揚子區；和 (3) 中國南部的錢塘江區。在第一個地區裏網筆石和樹筆石居主導地位，同時也有反稱筆石和苔蘚筆石出現（如太子河流域）。在第二個地區裏（即揚子區）刺筆石很多，最為特徵，共生的筆石多為細小的樹筆石。在最後一個地區裏（即錢塘江區）枝筆石和匿筆石是特有的種屬，同時也有反稱筆石和苔蘚筆石。但是尚未發現任何樹筆石和網筆石。也就是說錢塘江區

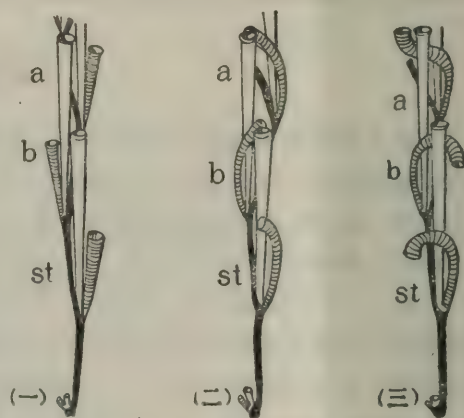


圖 3 示樹形筆石副胞管的幾種類型。根據 Bulman, 1938. 原有 6 種，此處採用 3 種。

(一) *Dictyonema flabelliforme* (Eichwald), (二) *D. cotyledon* Bulman, (三) *D. inconstans* Bulman. a, 正胞管; b, 副胞管; st, 莖胞管。



所見特馬豆克期的樹形筆石，全為反稱筆石科，尚無樹筆石科的種屬。開平—太子河區的筆石動物羣和北美洲的筆石動物羣相接近，錢塘江區的樹形筆石動物羣似乎和歐洲樹形筆石動物羣的關係比較密切，而揚子區的樹形筆石動物羣比較特殊，和上述兩區都有所不同。

開平—太子河區的樹形筆石產於石灰岩所夾的薄層頁岩裏面，冶里統中從上到下很多層裏都見到筆石。在開平盆地可以分作三個筆石帶，由下而上：(1) *Dictyonema-Asaphellus* 帶；(2) *Callograptus* 帶；(3) *Dichograptus* 帶。在太子河流域筆石的產出情況大致和開平盆地相同：(1) *Dendrograptus lotolatzensis* 帶；(2) *Dictyonema flabelliforme liaotungense* 帶相當於開平盆地的 *Dictyonema-Asaphellus* 帶及 (3) *Callograptus? taitzeensis* 帶大致和開平盆地的 *Callograptus* 帶相當。揚子區的特馬豆克期筆石也是產在石灰岩所夾的薄層頁岩裏，但是僅在宜昌統的上部，即 *Acanthograptus sinensis* 帶中見到筆石；下面兩個化石帶中尚未發現筆石。錢塘江區的特馬豆克期筆石產於印渚埠頁岩（狹義的）的中部。印渚埠頁岩的三個化石帶中也僅有中間的一個化石帶，即 *Clonograptus-Triarthrus* 帶產筆石，其餘兩個化石帶中均未見筆石。

所有中國這些特馬豆克期的樹形筆石都是和三葉蟲、介形蟲、腕足類等共生的，即所謂筆石與甲殼的混合相，都是產在黃綠色頁岩裏。由於反稱筆石和苔蘚筆石的出現，錢塘江區的 *Clonograptus-Triarthrus* 帶可以和開平—太子河區的 *Callograptus* 帶相對比。但是，揚子區的 *Acanthograptus* 帶和其他兩區的筆石帶如何對比，則比較困難。就其共生的化石如三葉蟲、介形蟲、腕足類等及其上下層位看來，*Acanthograptus* 帶大致可以和北方的 *Dichograptus* 帶相比，而較南方的 *Clonograptus-Triarthrus* 帶的層位為高。開平—太子河區的 *Dictyonema-Asaphellus* 帶及錢塘江區的 *Hysterolenus* 帶與揚子區的 *Dactylocephalus* 帶大致相當，可能相當於歐洲的 *Dictyonema flabelliforme* 帶。開平—太子河區的 *Callograptus* 帶及錢塘江區的 *Clonograptus-Triarthrus* 帶或可與歐洲的 *Clonograptus-Adelograptus* 帶（即以前所說的 *Bryograptus* 帶）相比。茲將中國各地區的特馬豆克期筆石帶對比如下：

開 平 — 太 子 河 區	揚 子 區	錢 塘 江 區
<i>Dichograptus</i>	<i>Acanthograptus</i>	<i>Asaphopsis-Birmanites</i>
<i>Callograptus</i> <i>Dictyonema-Asaphellus</i>	<i>Asaphopsis</i> <i>Dactylocephalus</i>	<i>Clonograptus-Triarthrus</i> <i>Hysterolenus</i>

#### 四. 種 的 描 述

樹形筆石目 (*Dendroidea* Nicholson, 1872)

樹筆石科 (*Dendrograptidae* Roemer, 1897)

網筆石亞科 (*Dictyoneminae* Mu, 1953)

網筆石屬 (*Dictyonema* Hall, 1851)

寒 武 紀 種 族

*Dictyonema wutingshanense* Mu (新種)

(圖版 I, 圖 1-4)

此種筆石有好幾個標本，保存在黃色泥質石灰岩裏，其中有一個比較完整的筆石體或複體 (*Rhabdosome* or *polyptych*)。

筆石體作圓錐形，分散角（即錐頂角）約為  $45^\circ$ ，軸心高度為 11.5 毫米，最大直徑為 7 毫米。胎胞管（或簡稱胎管）相當長，其長度約為 1.8 毫米。筆石枝（stipe）很細，其寬度僅為 0.2 毫米。筆石枝分枝的角度很小。在 5 毫米的寬度間有 5—6 個筆石枝，各枝間的空隙相當於筆石枝寬度的 4—5 倍。

橫靶（dissepiment）細直，和枝的軸向垂直，橫靶分佈不規則，通常彼此相距約 2—3 毫米。有些橫靶可能在此種筆石保存成有化石以前已經斷去。

從筆石枝的背部看來，胞管（theca）極不清楚，但在側面保存的筆石枝上，正胞管（autotheca）的形狀頗為清楚，排列成鋸齒狀。這些正胞管和筆石枝的軸向之間造成極小的角度。正胞管的口緣平，腹緣凹入，形成向外伸展的細小口尖。在筆石枝 5 毫米的長度中，有正胞管 8—6 個，正胞管的長度約為 1 毫米，相鄰胞管間的掩蓋部分不及胞管長度的  $\frac{1}{2}$ 。副胞管（bitheca）不清楚。

上面的描述是根據此種筆石的正型標本（holotype）（圖版 I，圖 1—2）。在另一個幼年標本即作為副型標本（paratype）（圖版 I，圖 3）裏，胎胞管是一個細長的圓錐體，在胎胞管的頂端有一個很小的浮盤，靠近胎胞管的頂部（可能是原胎管 prosicula）伸出一個原始枝，這個原始枝向下斜伸，很快又行分枝，由於胎胞管及浮盤的存在，這一種原始的筆石應當是浮游的生物。

**比較：**從筆石體的形狀和筆石枝的分枝情形看來，我們的這個新種很像北美洲 Navy 島 *Dictyonema* 層中的 *Dictyonema flabelliforme* var. *ruedemanni* Hahn；但是，這個新種的筆石體較小，筆石枝較細，同時筆石枝的排列和在一定長度間的胞管數目也不相同。這種筆石用它的微小筆石體和很細的筆石枝很容易和網筆石的其他種族相區別。

**層位及產地：**此種筆石產於遼寧遼陽縣烟台五頂山的上寒武紀鳳山統 *Dictyonema wutingshanense* 帶（包括在 *Quadricephalus* 帶內），共生的筆石有 *Dendrograptus* sp.。

**登記號碼：**7258 a-b（正型標本），7259—7261（副型標本）。

### *Dictyonema* sp. A.

（圖版 I，圖 5）

此種筆石祇有一個破碎的標本，筆石體完整的形狀不可得知。筆石枝相當粗大，其寬度約為 0.7 毫米；分枝角度相當大，但是，所分成的兩個枝很快的向內轉，以致兩枝大致平行。橫靶比筆石枝細，有的和筆石枝正交，有的斜交，橫靶分佈也不規則，大致相距 2—3 毫米。因為標本保存得不佳，胞管性質不明。

**層位及產地：**內蒙古清水河縣黃河岸的上寒武紀鳳山統 *Quadricephalus* 帶。

**登記號碼：**7262 a-b（正型標本）。

### 奧陶紀種族

#### *Dictyonema flabelliforme* var. *liaotungense* Mu

（圖版 I，圖 6—10；插圖 4）

1953. *Dictyonema flabelliforme* var. *liaotungense*, 穆恩之, 古生物學報, 第 1 卷, 第 1 期, 頁 29, 圖版 I, 圖 1.

此種筆石有兩個標本，一個是保存良好的筆石體，一個是筆石體的始端一小部分。筆石體呈漏斗狀，胎胞管部分已經斷去，從斷裂處量起，筆石體高 44 毫米，最大寬度約為 30 毫米，長與寬之比為 1.5: 1。筆石枝為正分枝（dichotomous branching），分枝規則。各枝的分枝距離相當，向末端逐漸增加。從始端到末端，分枝的距離依次為 3 毫米、10 毫米、15 毫米等等，形成分枝帶（zone of branching）。所有筆石枝近乎直伸，稍微彎曲；筆石枝的背部具有波狀條紋，各枝互相平行，排列緊密，在 10 毫米的寬度中有 14 個枝。筆石枝的寬度，始末均一，約為 0.4 毫米。枝間的距離大致和枝的寬度相等或稍微小些。但有些地方由於筆石枝保存的方向不同。其寬度也不一樣。



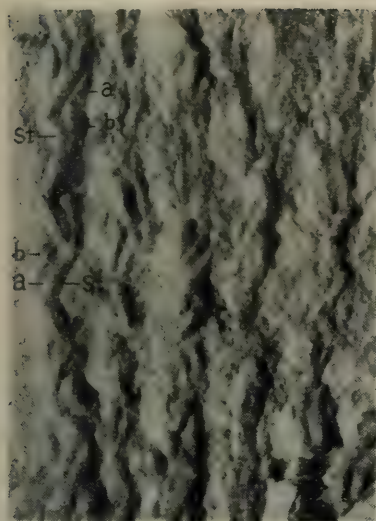


圖 4 *Dictyonema flabelliforme* var. *liaotungense* Mu. 筆石體的一部分放大  $\times 10$ , 示筆石枝的視背。a, 正胞管; b, 副胞管; st, 莖胞管。

石枝具有輕微的波狀彎曲,而 *graptolithinum* 的筆石枝則是勁直的,同時網格的形狀也不相同。就筆石枝的分枝帶看來,此種筆石很像 *Dictyonema flabelliforme flabelliforme* Eichwald; 但據 Obyr 重新研究該種原來的標本指出,該種筆石的網格為卵形,因而各枝呈波浪狀;和我們的這種筆石比較,網格的形狀大不相同。由於有絞結的存在,我們的這種筆石多少有些像 *Dictyonema flabelliforme* var. *desmograptoides* Hahn; 但是絞結的數目很少,同時其他性質也差別很遠。此一變種和 *Dictyonema flabelliforme* 的其他變種之間的比較,請參閱筆者前文 (1953) 第 29 頁的第 3 表。

**層位及產地:** 此種筆石是東北太子河流域治里統下部 *Dictyonema flabelliforme liaotungense* 帶的帶化石,產於遼寧本溪駱駝砬子。

**登記號碼:** 7263 a-b (正型標本), 7264 (副型標本)。

### *Dictyonema uniforme* Mu

(圖版 I, 圖 11—13)

1953. *Dictyonema uniforme*, 穆恩之, 古生物學報, 第 1 卷第 1 期。圖版 I, 圖 9。

筆石體細長,軸心長度為 28 毫米,最大寬度為 9.5 毫米,長與寬之比為 3:1。筆石枝為規則的正分枝,在筆石體的始部分枝距離為 5 毫米,在末部則為 8—12 毫米。因為各枝的分枝距離相等,遂形成分枝帶。所有筆石枝互相平行,近乎直伸,稍微彎曲。筆石枝的寬度均勻,約為 0.3 毫米,各枝排列緊密,在 5 毫米的寬度中有 8 個枝。在壓扁了的筆石體中,見到 16—17 條末枝 (terminal stipes)。各枝間的距離較枝的寬度略大。

橫靶細直,與枝正交,分佈不規則。

胞管的性質難以窺知,因為所有的筆石枝全是看到背面,沿着枝的兩邊僅可看到細小而且彎曲的胞管痕跡,可能是正胞管,在 10 毫米的長度中約有胞管 16 個。

橫靶的寬度和筆石枝的寬度相當或稍微小些,通常是橫列,和筆石枝垂直;但是偶然也有斜交的。橫靶分佈相當規則,各橫靶間的距離通常為 4.5 毫米。因而橫靶與筆石枝造成長方形的網格。橫靶的數目不多,在 10 毫米的長度中有 2—3 個橫靶。在筆石體的始部,偶然可以看到筆石枝間的絞結 (anastomosis)。

胞管生於錐形筆石體的內側,正胞管和副胞管都是簡單的直管,副胞管較小。莖胞管左右彎曲,因而形成波狀的系列。由筆石枝的側面看來,正胞管呈鋸齒狀,在枝的 10 毫米長度中有 15—14 個正胞管。由於筆石體的始端已斷去,胎胞管的性質不得而知。

**比較:** 此種筆石在主要性質上和 *Dictyonema flabelliforme* Eichwald (廣義的) 相同,顯然應為該種的一個變種,或者是 *Dictyonema flabelliforme* (狹義的) 組中的一個獨立的種。就筆石枝分枝的情況和胞管的性質看來,我們的這種筆石和 *Dictyonema flabelliforme* var. *graptolithinum* Kjerulf 最為接近 (蘇聯古生物學家 A. M. Obyr 指出 *Dictyonema flabelliforme forma typica* Brögger 應為 *Dictyonema graptolithinum* Kjerulf, 筆者此處將此一筆石當作 *Dictyonema flabelliforme* Eichwald 的變種,因為它們的主要性質相同),但是我們這種筆石的筆

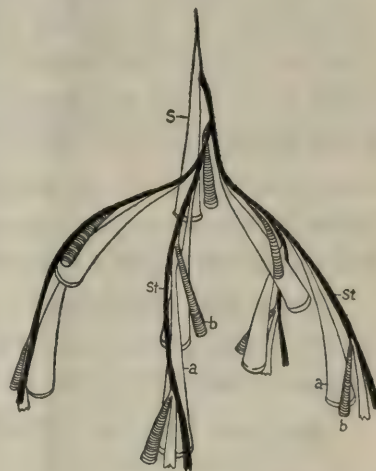


圖 5 *Dictyonema flabelliforme* (Eichwald). 示筆石體始部胞管發育的情形,根據 Bulman, 1927 及 1938. s, 胎胞管; a, 正胞管; b, 副胞管; st, 莖胞管。



**比較：**由細長的筆石體及平行的筆石枝看來，此種筆石很像 *Dictyonema flabelliforme* var. *sociale* (Salter)，但是網格的形狀不同。驟然看起來，此種筆石有些像 *Callograptus salteri* Hall，但是此種筆石的橫耙數目較多。從外形上看來，此種筆石介於 *Dictyonema flabelliforme* 和 *Callograptus salteri* 之間。

**層位及產地：**此種筆石產於遼寧本溪豆房溝及遼陽烟台五頂山冶里統的 *Callograptus?* *taitzehoensis* 帶。共生的筆石有 *Aiograptus* sp. aff. *furciferus* Ruedemann, *Callograptus?* *taitzehoensis* Mu, *Dendrograptus odontocauloides* Mu, *D. suni* Mu (新種), *D. y-wangi* Mu (新種) 等。

**登記號碼：**7265 a-b (正型標本), 7266 a-b (副型標本)。

### *Dictyonema flexiliramosum* Mu (新種)

(圖版 II, 圖 11—13)

因為未見此種筆石的完整標本，其筆石體的形狀不明。一個比較好的標本，即正型標本 (圖版 II, 圖 13)，長約 20 毫米，包含 8 個筆石枝。筆石枝的背視 (dorsal view) 很細，僅 0.2 毫米，但其側視則寬達 0.4 毫米 (經過胞管口部量起)。這些筆石枝極其曲折，如同絞結筆石 (*Desmograptus*) 的筆石枝；但是並無絞結存在。在筆石體的始部各枝擠在一起，但到末部則逐漸分開。

橫耙數目不多，通常短而細。

在側面保存的筆石枝上胞管呈尖齒狀，具有尖銳的口尖。胞管口緣寬，稍微凹入，在 10 毫米的長度中有 20—18 個正胞管。副胞管不清楚。

**比較：**由筆石枝的纖細、曲折及其緊密排列等性質看來，此種筆石接近北美洲紐芬蘭 Green Point 組 (特馬豆克期) 的 *Dictyonema bulmani* Ruedemann 及 St. Paul's 組 (下奧陶紀) 的 *Dictyonema simile* Ruedemann；但是我們的這種筆石，胞管排列得比較緊密，筆石枝的曲折情形也不相同。上述兩種北美洲的筆石，筆石枝大體上看來是稍微彎曲的，但仔細看來，則是一連串的齒狀小曲折；和我們這種具有波浪折曲的筆石枝不同。我們的這種筆石和其他具有曲折筆石枝的網格筆石相比較，如北美洲的 *Dictyonema flabelliforme* var. *desmograptoides* Hahn (特馬豆克期) 及 *Dictyonema desmoides* Gurley (志留紀) 和歐洲的 *Dictyonema geniculatum* Bulman (志留紀) 等，其主要差別是在我們的這個新種沒有絞結；同時在單位長度中的胞管數目也不相同。

**層位及產地：**遼寧遼陽烟台五頂山及本溪田師付的冶里統 *Callograptus?* *taitzehoensis* 帶。共生的筆石有 *Reticulograptus yangi* Mu (新種), *Callograptus sinicus* Mu (新種), *C. curvithecalis* Mu (新種), *C.?* *taitzehoensis* Mu 等。

**登記號碼：**7267 a-b (正型標本), 7268, 7269 (副型標本)。

### *Dictyonema asiaticum* Hsü

(圖版 II, 圖 1—5)

1948. *Dictyonema asiatica*, 許傑, 中央研究院地質研究所叢刊第 8 號, 第 11—12 頁, 圖版 I, 圖 1, 2 a-b, 3, 4.

此種筆石是許傑教授於 1948 年根據湖北宜都八字壩及宜昌分鄉場的材料所創立的新種。本文此處所討論的材料除從長陽所採得的標本以外，尚有王鈺先生從宜昌分鄉場所採而許傑教授未曾研究過的幾個標本。

筆石體為較寬的圓錐形，長與寬大致相當。筆石枝細，其寬度為 0.2—0.3 毫米。各枝大致平行，稍微彎曲，分枝不規則。在 10 毫米的寬度中有 15—17 個枝。

橫耙細，係從副胞管的口部生出。

在側面保存的筆石枝裏 (圖版 II, 圖 5)，胞管比較清楚。正胞管為長的直管，相鄰胞管間掩蓋 ⅓，在 5 毫米的長度中有 8 個正胞管，每一個正胞管的口部，生出一個細長而且分叉的口刺。副胞管較小。

關於此種筆石的詳細描述，請參閱許傑教授 1948 年的著作。



**比較：**從胞管的口刺看來，此種筆石很像加拿大奎必克 Matane 頁岩中的 *Dictyonema canadense* Lapworth，但是筆石枝的性質不同。此種筆石和 *Dictyonema cervicorne* Holm, *D. tuberosum* Wiman 等具有口刺的網筆石代表着網筆石中顯明的一個組。

**層位及產地：**此種筆石產於鄂西宜昌統 *Acanthograptus* 帶的下部，共生的筆石有 *Callograptus yangtzensis* Mu (新種), *Acanthograptus sinensis* Hsü 等。

**登記號碼：**7270—7273 (近型標本)。

### ***Dictyonema szzechuanense* Mu (新種)**

(圖版 II, 圖 9—10)

筆石體大概是錐形，不完整的標本長 13 毫米，寬 9 毫米。筆石枝細微如線，在 5 毫米的寬度中有 11 個枝。各枝間間隙與枝的寬度相等或略大。在枝的末部稍微彎曲。分枝不規則，分枝距離通常為 4 毫米。

在筆石枝的背面看不到胞管，在枝的側面可以看見齒形的胞管，可能是正胞管，胞管口部具有非常細小的口刺。胞管排列緊密，在 5 毫米的長度中有 11—10 個胞管。副胞管及莖胞管的形狀不得而知。

橫靶不規則，通常與枝斜交。在 5 毫米的長度中有 5—6 個橫靶。這些橫靶一般都很細微，有的在一端變粗。

**比較：**此種筆石在筆石體的大小、形狀以及筆石枝的寬度上和蘇聯中奧陶紀的一種網筆石 *Dictyonema yeltyschevae* Obut 非常相似。但是蘇聯的那種筆石保存得不佳，胞管的性質不明，不敢確定是否與我們這一種相同。從筆石枝的寬度及其排列的情形看來，此種筆石又像北美洲奧陶系中的 *Dictyonema desum* Ruedemann；但是後者的筆石枝，分枝比較規則。由於口刺的存在，此種筆石可以歸入 *Dictyonema asiaticum* 組中。此種筆石以其細小的口刺容易和此組中的其他筆石相區別。

**層位及產地：**此種筆石產於四川華蓥山的中奧陶紀艾家山統中，與 *Ptilograptus glomeratus* var. *sinicus* Mu (新變種) 共生。

**登記號碼：**7274 a-b (正型標本)。

### ***Dictyonema* sp. B.**

(圖版 II, 圖 7—8)

此種筆石僅有幾個破碎的標本，這些標本僅保存有幾個筆石枝，普通為 7—8 個枝。因此筆石體的形狀不得而知。各枝近於平行，具有波狀曲折；分枝距離為 5—7 毫米。各枝間的距離由和枝的寬度相當到大於枝的寬度的兩倍。各枝間有橫靶相連，這些橫靶在分佈上及位置上都不規則。

正胞管短小，排列緊密，在 5 毫米的長度中有 10—9 個胞管。副胞管及莖胞管不易識別。

**比較：**此種筆石在筆石枝的曲折性質上看，很像 *Dictyonema simile* Ruedemann；但是我們這種筆石的筆石枝並不像北美洲的那種筆石作齒狀折曲。同樣情形，此種筆石也有些像 *Dictyonema flexiliramosum* Mu (新種)，但是筆石枝的寬度及胞管的性質均不相同。驟然看起來，此種筆石也有些 *Dictyonema asiaticum* Hsü；不過此種筆石的胞管短，沒有口刺。由此看來，這種筆石顯然是一新種，可是標本過於零碎，不值得給一新的種名。

**層位及產地：**此種筆石產於遼寧本溪豆房溝及遼陽烟台五頂山冶里統的 *Callograptus?* *taizheensis* 帶。

**登記號碼：**7275 (正型標本), 7276 (副型標本)。

### ***Dictyonema* sp. C.**

(圖版 II, 圖 6)

完整的筆石體形狀不得而知。不完整的標本包含幾個擠在一起的筆石枝，此一標本長 17 毫米，寬 4

毫米。筆石枝互相平行，幾乎互相接觸，也就是說，各枝間的空隙很小，筆石枝的寬度為 0.7 毫米（口刺不計算在內）。

胞管（大概是正胞管）呈三角形，具有極細小的口刺，看起來已和相鄰的前一枝相接觸；胞管伸出的部分相當筆石枝寬度的一半，在 10 毫米的長度中有 14 個胞管。副胞管和莖胞管不易識別。橫靶的數目在筆石體的始部較多，在末部較少。

**比較：**由具有口刺的胞管及其突出的情況看來，此種筆石很像是 *Airograptus* 的一種，但是此種筆石的橫靶較多，胞管的口刺比較細微。用這種伸出的胞管性質，此種筆石可以與 *Dictyonema* 的其他種族相區別。此種筆石顯然是一個新種，可是在獲得比較完整的標準之前，還沒有給以新種名的必要。

**層位及產地：**貴州湄潭岩孔堡中奧陶紀艾家山統。

**登記號碼：**7277（正型標本）。

### 志留紀種族

#### *Dictyonema* sp. aff. *D. delicatulum* Lapworth

（圖版 III，圖 1）

Cf. 1881. *Dictyonema delicatulum*, Lapworth, Quart. Journ. Geol. Soc., 卷 37, 頁 172, 圖版 VII, 圖 2 a-b.

Cf. 1926. *Dictyonema delicatulum*, Bulman, Monogr. Pal. Soc. London, 卷 80, 頁 51, 圖版 VI, 圖 7-11.

這種筆石我們祇有一個標本及其反對面（counterpart），在黑色頁岩裏保存成為白色的薄膜。標本不完整，僅保存六個筆石枝，長 13 毫米，寬 3 毫米。所有這些筆石枝都很細，寬度始末一致，約為 0.25 毫米。驟然看來，這些筆石枝都是直的，但是仔細觀察，具有極小的齒狀折曲；各枝互相平行，分枝的距離相當大，即分枝次數不多；各枝間的距離相當規則，大致相當於枝的寬度的兩倍。

因為筆石枝保存成為薄膜，胞管的構造不清楚，依照筆石枝的折曲次數看來，大約在 10 毫米的長度中有 20 個胞管。

橫靶很細，不規則，有的和筆石枝正交，有的斜交；在 5 毫米的長度內約有 5—6 個橫靶。

**比較：**我們這個標本在筆石枝及橫靶等的主要性質上和英國志留紀的 *Dictyonema delicatulum* Lapworth 相同，地層層位也大致相當，大概是同一種；可是我們的標本不完整，同時胞管的性質不明，不知是否具有口刺，不便作確當的鑑定。

**層位及產地：**據筆者所知，截至目前為止，此種筆石是中國志留紀地層中惟一的樹形筆石，產於西康天全龍馬溪頁岩（下志留紀）的 *Monograptus* (*Demirastrites*) *convolutus* 帶中，和許多單筆石科的筆石共生。

**登記號碼：**7278（近型標本）。

#### 交織筆石屬 (*Reticulograptus* Wiman, 1901)

##### *Reticulograptus yangi* Mu (新種)

（圖版 III，圖 9-12）

此種筆石有好幾個不完整的標本，有些是筆石體的始部，有些是筆石體的末部。筆石體可能是長錐形，始端圓。筆石體始部的筆石枝相當粗，寬約 0.8 毫米；各枝排列得很緊密，其間聯以粗大的橫靶。筆石體末部的筆石枝較細，寬約 0.5 毫米，各枝間有絞結或斜的橫靶相聯，形成菱形網格；在 5 毫米的寬度中有 6—7 個筆石枝。筆石枝的背部呈現平行而直的條紋，可能是表示着胞管的複雜的組合情況，胞管的詳細性質尚不得知。

**比較：**由網格的形狀看來，此種筆石很像北美志留紀的 *Reticulograptus polymorphus* (Gurley)，但是我們此一新種的筆石體比較細長，筆石枝比較粗壯，而且產出的地層層位也差得很遠（我們這一種產於下奧陶紀初期）。



**層位及產地：**此種筆石出現於遼寧省本溪縣田師付冶里統的 *Callograptus? taitzeensis* 帶中，共生的筆石有 *Callograptus curvithecalis* Mu (新種), *C. sinicus* Mu (新種)等。

**登記號碼：**7285 — 7288 (共型標本)。

### 絞結筆石屬 (*Desmograptus* Hopkinson, 1875)

#### *Desmograptus* sp.

(圖版 III, 圖 13—14)

筆石體呈掃帚狀，很小，長僅 10 毫米，寬約 2 毫米。筆石體的始端具有一個長 2.5 毫米的莖，從莖的末端生出幾個波狀曲折的筆石枝，筆石枝很細，寬約 0.3 毫米，分枝距離不規則。各枝間有絞結及橫靶相聯，但為數不多。枝間的距離大致和枝的寬度相等，在 2 毫米的寬度內有 4—5 個筆石枝。

由於標本保存成為薄膜，胞管的性質不明。

**比較：**從筆石體的大小及形狀上來看，這種筆石很像河北開平盆地冶里統的 *Desmograptus yehliensis* Sun，但是此種筆石的筆石枝其曲折程度遠不如後者，此種筆石可能是一新種，但標本不多，保存不好，不值得給一新的種名。

**層位及產地：**湖北長陽高家嶺宜昌統的 *Acanthograptus sinensis* 帶上部，共生的筆石有 *Dendrograptus yangtzensis* Mu (新種), *D. yini* Mu (新種), *Acanthograptus macilentus* Hsü, *A. rigidus* Hsü, *A. flexilis* Mu (新種), *A. intermedius* Mu (新種)等。

**登記號碼：**7289 (正型標本)。

### 無羽筆石亞科 (*Callograptinae* Mu 1953)

#### 持握筆石屬 (*Airograptus* Ruedemann, 1916) (修正)。

**修正定義：**固着的筆石體，大致是圓錐形，具有一個短莖。筆石枝為正分枝，在筆石體始部筆石枝分枝的次數多，在末部分枝的次數少；筆石枝相互平行或者近乎平行。枝間的橫靶極為稀少，或者沒有橫靶。胞管為齒狀，具有分叉的片狀口刺，此種口刺可能觸及相鄰的筆石枝。

**型屬：***Dictyonema furciferum*, Ruedemann, 1904

#### *Airograptus* sp. aff. *A. furciferus* (Ruedemann)

(圖版 III, 圖 15—17; 插圖 6)

Cf. 1904. *Dictyonema furciferum*, Ruedemann, New York State Mus., Mem. 7 頁 606—607, 圖版 III, 圖 11.

Cf. 1912. *Callograptus grabaui*, Hahn, N. Y. Acad. Sci. Ann., 卷 22, 頁 142—144, 插圖 1, 圖版 20.

Cf. 1916. *Airograptus* (*Dictyonema*) *furciferus*. Ruedemann, N. Y. State Mus., Bull. 189 頁 17—21, 插圖 7—8.

Cf. 1947. *Airograptus furciferus*, Ruedemann, Geol. Soc. Amer., Mem. 19, 頁 195—196, 圖版 IV, 圖 1—2.

1953. *Airograptus* sp. aff. *A. furciferus* 穆恩之, 古生物學報, 第 1 卷第 1 期, 頁 29, 圖版 I, 圖 2.

這種筆石祇有兩個破碎的標本，標本雖然破碎，主要性質還保存得很清楚。其中一個標本包含有兩個分枝的筆石枝，另一標本則是一個筆石枝的一段。在前一標本（圖版 III, 圖 15—16）的始部筆石枝作正分枝，分枝的角度很小，各枝緊密排列，互相平行，在 15 毫米處再行分枝；筆石枝直，其寬度約為 0.7 毫米（胞管的口刺不計算在內）。

正胞管細長，側面看來，排列成為齒狀，具有分叉的片狀口刺，口刺長 0.7 毫米。胞管軸向和筆石枝軸向之間造成很小的角度，在 10 毫米的長度中有 17 個正胞管，相鄰胞管之間掩蓋其長度的  $\frac{2}{3}$  或強。副胞管為簡單的直管，其長度僅當正胞管的一半，無口刺。

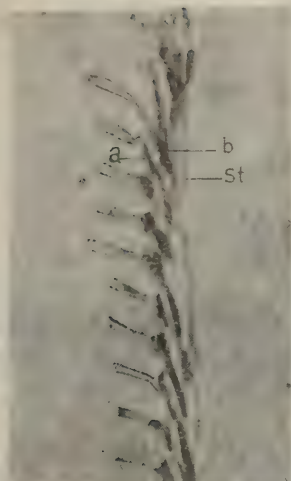


圖 6 *Airograptus* sp. aff. *A. furciferus* (Ruedemann) 筆石枝的一部分放大  $\times 10$ , 示胞管及其口刺的性質。a, 正胞管; b, 副胞管; st, 莖胞管。

**比較:** 此種筆石在各方面都和北美洲的 *Airograptus furciferus* Ruedemann 相同, 例如筆石枝分枝的情形, 胞管的形狀以及具有特殊的口刺等。所不同的是我們這種筆石的筆石枝比較寬。筆者在另一文(見穆恩之, 1953, 頁 29 及 34)中認為持握筆石(*Airograptus*)一屬和無羽筆石(*Callograptus*)之間的關係比與網筆石(*Dictyonema*)之間的關係來得密切。此屬的筆石枝平行或近於平行, 橫靶極少等等性質和無羽筆石的性質相同。所不同的僅僅是具有特殊的口刺。Ruedemann 將歐洲的 *Dictyonema cervicorne* Holm, *D. tuberosum* Wiman, *D. peltalum* Wiman 及 *D. cavernosum* Wiman 等都歸入持握筆石(見 Ruedemann, 1947 頁 195), 筆者認為上列這些具有胞管口刺的筆石, 橫靶很多, 仍應當是屬於網筆石, 不是持握筆石。它們代表網筆石中明顯的一組, 即上面所說過的 *Dictyonema asiaticum* 組。

**層位及產地:** 此種筆石產於遼寧本溪豆腐溝冶里統的 *Callograptus taitzeensis* 帶中, 共生的筆石有 *Dictyonema uniforme* Mu, *Callograptus taitzeensis* Mu, *Dendrograptus odontocauloides* Mu, *D. suni* Mu(新種), *D. y-wangi* Mu(新種)等。

登記號碼: 7290 a-b, 7291 (近型標本)。

### 無羽筆石屬 (*Callograptus* Hall, 1865)

#### 寒武紀種族

#### *Callograptus staufferi* Ruedemann

(圖版 IV, 圖 1-2)

1933. *Callograptus staufferi*, Ruedemann, Bull. Mus. Milwaukee, 卷 12, 期 3, 頁 319-320, 圖版 50, 圖 1-7; 圖版 55, 圖 1, 2, 5.

1947. *Callograptus staufferi*, Ruedemann, Geol. Soc. Amer. Mem. 19, 頁 204, 圖版 16, 圖 7-15.

這種筆石有兩個標本, 其中一個標本(圖版 IV, 圖 1)筆石枝直或稍微彎曲, 相互平行, 或近於平行; 這些枝的分枝距離約為 4 毫米或稍強; 所分成的兩個枝間造成很小的角度; 筆石枝的寬度均勻, 無大變化, 約為 0.5 毫米。在 5 毫米的寬度中有 5 個筆石枝。

橫靶極為稀少, 而且非常細微。有的已經斷去, 僅在筆石枝的兩側存留着很小的突起。

胞管(可能是正胞管)側面呈齒狀, 腹緣稍微凹入, 相鄰胞管之間掩蓋胞管長度的  $\frac{1}{2}$  或強, 在 10 毫米的長度中有胞管 14 個。正胞管、副胞管及莖胞管不易區別。

另一標本(圖版 IV, 圖 2)是一幼年標本, 極似 Ruedemann 曾經描述過的一個北美洲標本(見 Ruedemann, 1933 圖版 50, 圖 4)。筆石枝相當細, 分枝間的距離為 2 毫米。

**比較:** 此種筆石在各方面均和 Ruedemann 所描述過的北美洲寒武紀標本相同, 產出的地層層位也相當, 應為同一種。此種筆石的破碎標本在外形上看很像奧陶紀的種族如 *Callograptus salteri* Hall 及 *C. hopkinsoni* Bulman, 但是, *Callograptus salteri* Hall 的筆石枝較細, 常具有波狀曲折, *Callograptus hopkinsoni* 的筆石枝則更粗大。如有完整標本, 這些筆石是很容易區別的。

**層位及產地:** 山西偏關縣黃河岸的上寒武紀鳳山統 *Quadricephalus* 帶。



登記號碼：7292, 7293 (近型標本)。

### 奧 陶 紀 種 族

### *Callograptus curvithecalis* Mu (新種)

(圖版 IV, 圖 12—16; 插圖 7)

1953. *Callograptus* sp. aff. *C. salteri*, 穆恩之, 古生物學報, 第 1 卷第 1 期, 圖版 I, 圖 8.

此種筆石有幾個保存良好的標本。筆石體為圓錐形, 高 25 毫米, 寬 20 毫米。筆石枝大體是直的, 僅有極微弱的彎曲, 各枝互相平行或近於平行, 排列得很密, 在 5 毫米的寬度中有 7—8 個枝; 所有筆石枝的寬度大致相同, 約為 0.3 毫米; 各枝間的距離由等於枝的寬度到大於枝寬度的兩倍。在筆石體的始部筆石枝的分枝距離較近, 約為 2—3 毫米; 在末部筆石枝的分枝距離遠, 約為 5—6 毫米; 分枝規則, 形成分枝帶。

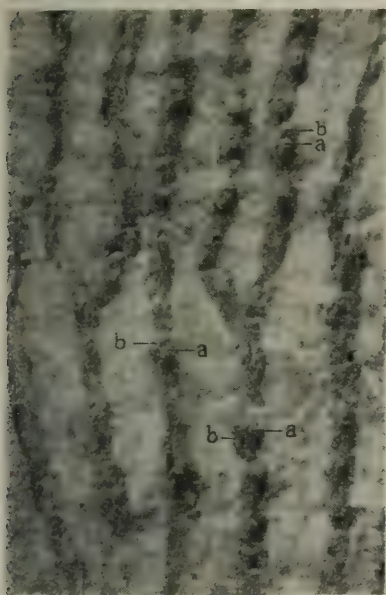


圖 7 *Callograptus curvithecalis* Mu(新種). 筆石體的一部分放大×10, 示直的正胞管(a)和彎曲的副胞管(b)之間的關係。

橫靶短而細, 數目很少, 分佈稀疏, 通常與枝正交。

在黃鐵鑲化的標本裏, 胞管突出, 非常清楚, 正胞管為簡單的直管, 由於副胞管橫過其後, 正胞管的末部向外伸展, 在 10 毫米的長度中有 10 個正胞管。副胞管彎曲如鉤, 即橫過前一代的正胞管之後, 開口於出生的對方, 屬於 Bulman 所說的 *Dictyonema falciferum* 式或 *Dictyonema inconstans* 式。

比較: 此種筆石的筆石枝分枝規則, 形成分枝帶。由這一點看來很像 *Callograptus salteri* Hall, 起初筆者鑑定此種標本時曾將此種筆石和該種相比 (1953), 但是仔細觀察起來, 此種筆石的副胞管呈彎鉤狀, 和 *Callograptus salteri* Hall 的胞管性質不同, 應為一新種。據筆者所知此為無羽筆石 (*Callograptus*) 中惟一具有彎曲副胞管的一種, 同時也是所有樹形筆石中具有彎曲副胞管最古老的一種。用這種特殊的副胞管可以將此種筆石和其他無羽筆石區別開來。但當保存不佳時, 此種筆石極易和 *Callograptus salteri* Hall 相混。

層位及產地: 此種筆石產於遼寧省本溪縣田師付溝冶里統的 *Callograptus? taitzeensis* 帶中, 共生的筆石有 *Reticulograptus yangi* Mu (新種), *Callograptus sinicus* Mu (新種) 等。

登記號碼: 7294—7296 a-b (共型標本)。

### *Callograptus sinicus* Mu (新種)

(圖版 IV, 圖 8—11)

此種筆石有上 10 個標本, 筆石體呈長錐形, 其長度約為 50 毫米, 寬度不及 20 毫米, 長度與寬度的比例為 2.5:1。在筆石體的始端有一個相當大的附着盤。筆石枝排列得很密, 在 10 毫米的寬度中有 16 個筆石枝; 這些筆石枝稍微彎曲, 其寬度為 0.25—0.3 毫米; 各枝間的距離大約與枝的寬度相當, 筆石枝分枝不規則, 無分枝帶。橫靶稀少。

在黃鐵鑲化的標本裏, 胞管的形狀很清楚, 正胞管為細長的直管, 口部微向外伸, 因而在筆石枝腹部的外模中可以見到一連串的小窪點; 副胞管稍微向內彎, 像是屬於 Bulman 的 *Dictyonema cotyledon* 式。

比較: 驟然看起來, 此種筆石很像 *Callograptus salteri* Hall, 但是仔細觀察以後, 可以得出此種筆石和 *Callograptus salteri* Hall 之間的區別有下列幾點: (1) 筆石體細長, (2) 筆石枝緊密排列而且分枝不規則, (3) 副胞管彎曲。此種筆石的不完整標本很像上面剛描寫過的 *Callograptus curvithecalis* Mu (新種), 但是此種筆石的筆石枝分枝不規則, 無分枝帶, 副胞管彎曲得不太顯著。

層位及產地：與前一種相同。

登記號碼：7297 a-b—7299 a-b (共型標本)。

### *Callograptus* sp. aff. *C. hopkinsoni* Bulman

(圖版 IV, 圖 6—7)

Cf. 1875. *Callograptus salteri*, Hopkinson, Quart. Journ. Geol. Soc., 卷 31, 頁 667, 圖版 XXXVI, 圖 10.

Cf. 1932. *Callograptus hopkinsoni*, Bulman, Pal. Soc. London, 卷 86, 頁 84—86, 插圖 41, 圖版 VIII, 圖 1—5.

此種筆石有兩個不完整的標本，其中之一(圖版 IV, 圖 6)包含 7—8 個筆石枝。所有這些筆石枝互相平行或近於平行，各枝間的距離很窄：筆石枝粗大，寬度約為 0.9 毫米，枝的末部稍微彎曲；在 10 毫米的長度中有 7—10 個枝。各枝分枝相當規則，分枝距離為 3, 3, 6 毫米，形成分枝帶。由於標本保存得不佳，胞管性質難以窺知。

比較：此種筆石在筆石枝主要性質上和英國奧陶系的 *Callograptus hopkinsoni* Bulman 相符合，可是我們的標本胞管不清楚，因此，這種鑑定也只是表面的。

層位及產地：此種筆石產於遼寧本溪駱駝砬子治里統下部的 *Dendrograptus lotolatzensis* 帶中，與 *Dendrograptus lotolatzensis* Mu (新種), *D. ptilograptoides* Mu (新種)等共生。

登記號碼：7300 a-b, 7301 a-b (近型標本)。

### *Callograptus yangtzensis* Mu (新種)

(圖 IV, 圖 3—5; 插圖 8)

筆石體不甚完整，長 13 毫米，寬 8 毫米。筆石枝為正分枝，在筆石體始部分枝距離為 1—3 毫米，到末部分枝的距離大為增長。各枝彎曲，但大致平行，筆石枝從背部看來，其寬度僅為 0.35 毫米，但在側面看來則寬度大增(從胞管口部量起，其寬度為 1 毫米)。

正胞管為稍微向腹部彎曲的長管，各個正胞管的末部大部分彼此孤立，外形如同耙筆石 (*Rastrites*)，胞管的長度約為 1 毫米；在 10 毫米的長度中有正胞管 16 個。副胞管比較短小，和正胞管緊靠，伸出不遠。橫耙稀少，偶可看見，從副胞管口部生出，與筆石枝斜交。

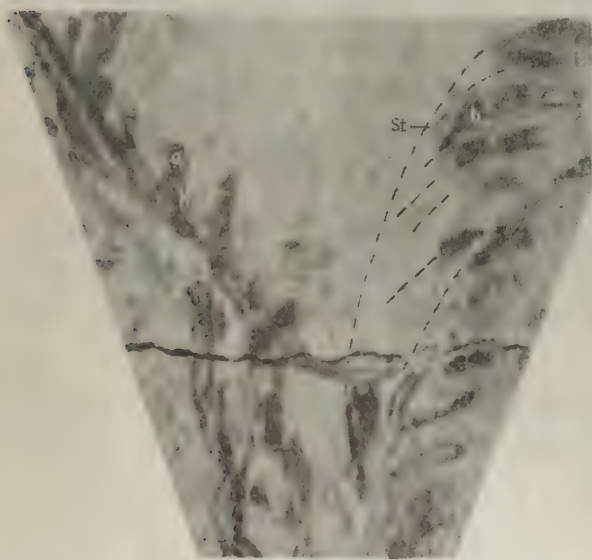


圖 8 *Callograptus yangtzensis* Mu (新種)。筆石體的一部分放大  $\times 10$ , 示孤立的胞管。a, 正胞管; b, 副胞管; st, 草胞管。

比較：由曲折的筆石枝看來，此種筆石像是絞結筆石 (*Desmograptus*) 的一種；但是各枝間沒有絞結相聯。

從孤立的正胞管看來，此種筆石和北美洲 Utica 頁岩中的 *Callograptus compactus* Ruedemann 最為接近，所不同的是此種筆石的筆石枝較粗，胞管的孤立程度較大；同時產出此等筆石的地層也差得很遠。*Callograptus compactus* 出現於上奧陶紀，而我們的這一新種則出現於下奧陶紀初期(特馬豆克後期)。必須指出這種筆石在筆石枝和胞管的外形上很像丹麥奧陶紀的 *Syrhipidograptus nathorsti* Poulsen，但後者的特徵是幾個筆石體生在一個橫平的莖上，僅有一個胞管，無副胞管，同時橫耙也不存在。

層位及產地：此種筆石出現於湖北長陽宜昌統的 *Acanthograptus sinensis* 帶中，與 *Dictyonema asiaticum* Hsü, *Acanthograptus sinensis* Hsü 等共生。



登記號碼：7302（正型標本）7303（副型標本）。

### *Callograptus? taitzehoensis* Mu

（圖版 V，圖 1—5）

1953. *Callograptus? taitzehoensis*, 穆恩之, 古生物學報, 第 1 卷第 1 期, 頁 34, 圖版 I, 圖 4.

筆石體為圓錐形，高約 20 毫米，寬度大致和高度相當，具有很短的莖。筆石枝互相平行或近於平行，為正分枝，分枝距離在筆石體的始部為 3 毫米，到末部則增長為 6 毫米，各枝的分枝距離大致相同，因而形成分枝帶。筆石枝的寬度為 0.3—0.4 毫米，各枝間的距離不及 1 毫米，在 10 毫米的長度中有 10 個筆石枝。

胞管的詳情不明，但依照筆石枝上複雜的印痕計算，在 10 毫米的長度中可能有 16 個胞管。正胞管與副胞管無法區分。橫靶全不存在。

**比較：**由筆石枝作規則的正分枝及橫靶的完全不存在看來，此種筆石很像下面將描述的 *Bryograptus yentaiensis* Mu（新種），但是此種筆石的筆石體大，具有莖，為固着的筆石體；而 *Bryograptus yentaiensis* 的筆石體小，並且具有顯著的胎胞管。從外形上看，此種筆石介於無羽筆石和樹筆石之間，可能代表一個新屬。

**層位及產地：**此種筆石是東北太子河流域治里統 *Callograptus? taitzehoensis* 帶的帶化石，和許多樹形筆石共生。

登記號碼：7304 a-b（正型標本），7305—7308（副型標本）。

### *Callograptus? taitzehoensis* var. *minor* Mu（新變種）

（圖版 V，圖 6—7）

此一筆石在主要性質上，如平行的筆石枝、具有分枝帶、全無橫靶等，和 *Callograptus? taitzehoensis* 相同，僅筆石體小得多，筆石枝細得多，故將此一筆石鑑定為該種的變種。

在保存得良好的標本裏胞管很清楚，正胞管、副胞管、以及莖胞管全是直管狀緊緊擁擠在一起；正胞管比副胞管及莖胞管長大，在 3 毫米的長度中有正胞管 5 個。

**層位及產地：**遼寧本溪豆腐溝治里統 *Callograptus? taitzehoensis* 帶和許多樹形筆石共生。

登記號碼：7309 a-b（正型標本），7310 a-b（副型標本）。

### 盾筆石屬 (*Aspidograptus* Bulman, 1932)

#### *Aspidograptus* sp.

（圖版 III，圖 8；插圖 9）

筆石體很小，可能是幼年標本，作扇形，直徑約為 9 毫米。主枝作弓形彎曲，從凸出的一側生出幾個側枝，這些側枝有的（在 2 毫米處）又行分枝；主枝和側枝的寬度相同，約為 0.6 毫米。筆石枝間偶然有很少很短的橫靶相聯。



圖 9 *Aspidograptus* sp. 放大  $\times 2$ ，同圖版 III，圖 8，示側枝在主枝一側排列的情形。

胞管短，排列較密，在 3 毫米的長度中有 4 個胞管（即在 10 毫米中約有 13 個胞管）。正胞管和副胞管不易區分。

**比較：**從筆石體的形狀看來，我們這種筆石很像英國奧陶紀的 *Aspidograptus? minor* Bulman 及 *Aspidograptus implicatus* (Hopkinson) 的始部。此種筆石和後者相比較，則胞管的排列比較稀疏，而和前者相比，則此種筆石的筆石枝比較粗大。

**層位及產地：**此種筆石產於鄂西長陽縣柑子坪宜昌統的 *Acanthograptus sinensis* 帶中，共生的筆石有 *Dictyonema asiaticum* Hsü, *Callograptus yangtzensis* Mu（新種），*Dendrograptus hupehensis* Mu（新種），*Acanthograptus sinensis* Hsü 等。

登記號碼：7311 (正型標本)。

樹筆石亞科 (*Dendrograptinae* Roemer emend. Mu, 1953)

(包括 *Ptilograptidae* Hopkinson)

樹筆石屬 (*Dendrograptus* Hall, 1858)

寒武紀種族

*Dendrograptus* sp.

(圖版 V, 圖 8)

附着的筆石體，很小，高度和寬度相當，約為 5 毫米。莖或主枝可能具有胞管（即所謂齒莖狀“*Odontocaulis* condition”），長僅 3 毫米，寬約 0.5 毫米。從莖的末端伸出兩個筆石枝，兩枝間造成約 90° 的角度；莖和枝的寬度相同，同樣都向背側稍微彎曲。由於標本保存不佳，胞管的性質不易觀察。

比較：此種原始的樹筆石，據筆者所知，是樹筆石中筆石體最簡單的一種。筆石體的形狀和下面將描述的 *Dendrograptus odontocauloides* 最為接近，但是此種筆石的筆石體很小也很簡單，這兩種筆石應當同屬於樹筆石屬中的一個組。

層位及產地：此種筆石產於遼寧省遼陽縣烟台五頂山上寒武紀鳳山統的 *Quadraticephalus* 帶，與 *Dictyonema wutingshanenses* Mu (新種) 共生。

登記號碼：7312 (正型標本)。

奧陶紀種族

*Dendrograptus odontocauloides* Mu

(圖版 V, 圖 12; 插圖 10)

1953. *Dendrograptus odontocauloides*, 穆恩之, 古生物學報, 第 1 卷第 1 期, 頁 30, 35; 圖版 I, 圖 3.



圖 10 *Dendrograptus odontocauloides* Mu, 放大  $\times 2$ , 同圖版 V, 圖 12, 示筆石體的齒莖及根狀構造。

筆石體形狀像樹，兩邊對稱，高 23 毫米，寬 17 毫米。在莖或主枝的始端具有一個很小的根狀構造，莖上具有胞管，即所謂齒莖狀“*Odontocaulis* condition”；莖長 10 毫米，寬 0.6 毫米，從莖的末端伸出兩個筆石枝，兩枝間造成 60° 的角度；這兩個筆石枝在 3.5 毫米的距離處各又連續分枝，各枝間造成尖銳的角。

所有的筆石枝和莖寬度相同，性質相似。在側面保存的筆石枝上可以看到齒狀的正胞管，胞管之間掩蓋其長度的  $\frac{1}{2}$ — $\frac{2}{3}$ ，在 10 毫米的長度中有正胞管 7—8 個。副胞管的性質不明。

比較：這種筆石是分枝比較規則的樹筆石之一。由它的分枝規則情形看起來，很像無羽筆石 (*Callograptus*) 的一種，但是各枝分散，並不平行，筆石體的形狀也不相同。用這種特殊的筆石體和規則的分枝，很容易將這種筆石和其他的樹筆石 (*Dendrograptus*) 區別開來。

層位及產地：這種筆石產於遼寧本溪豆房溝治里統的 *Callograptus? taitzeensis* 帶中，共生的筆石有 *Dictyonema uniforme* Mu, *Callograptus? taitzeensis* Mu, *Dendrograptus sinensis* Mu, *D. suni* Mu (新種), *D. y-wangi* Mu (新種) 等等。

登記號碼：7313 a-b (正型標本)。

*Dendrograptus sinensis* Mu

(圖版 V, 圖 13—15)

1953. *Dendrograptus thomasi* var. *sinensis*, 穆恩之, 古生物學報, 第 1 卷第 1 期, 圖版 I, 圖 7.

筆石體呈灌木狀，長 17.5 毫米，寬 15 毫米，未見筆石體的始端。從莖的末端伸出兩個主枝，兩主枝之間造成 60° 的角度，在各個主枝的兩側各生出若干側枝，分枝距離約為 2 毫米；這些側枝又行分枝，分枝的角度很小。所有主枝和側枝其寬度相當 (0.25 毫米)，始終均一，顯得勁直，沒有什麼彎曲。



正胞管爲小的直管狀，互相掩蓋其長度的一半，在 10 毫米的長度中有 16 個正胞管。副胞管更小，偶然可以看到。

**比較：**由筆石體的外形、筆石枝的寬度與分枝情形、以及胞管的排列上看來，這種筆石很像北美洲上寒武系中的 *Dendrograptus thomasi* Ruedemann，因此，筆者（1953）曾將此種筆石當作該種的變種；但是，*Dendrograptus thomasi* 的筆石枝比較曲折，而且排列較密；如此，將我們這種筆石當作一個獨立的種似乎更好一些。

**層位及產地：**與前一種筆石 *Dendrograptus odontocauloides* 相同。

**登記號碼：**7314 a-b（正型標本）。

### *Dendrograptus suni* Mu（新種）

（圖版 V，圖 9—11）

筆石體呈樹形，大致兩邊對稱，長 22.5 毫米，寬 8.5 毫米。從一個很短的莖上生出兩個主枝，這兩個主枝又各再連續分枝，分枝的方式有正分枝也有側分枝；分枝的距離大約爲 3—5 毫米，分枝的角度在 30—40° 之間。主枝和側枝，其性質相同，寬度相等，由始到終，枝的寬度均一，約爲 0.6 毫米。筆石枝稍微曲折，排列緊密，在 5 毫米的寬度中有 4—5 個筆石枝。

正胞管爲長管狀，在筆石枝的側面看來，呈齒形，在 5 毫米的長度中有 8—9 個正胞管。副胞管爲小的簡單的直管。

**比較：**在筆石體的形狀上，此種筆石像河北開平盆地冶里統中的 *Dendrograptus grabaui* Sun，尤其像 *Dendrograptus cf. grabaui* Sun（見孫雲鑄 1935，圖版 I，圖 8a—b），但是，此種筆石的筆石枝比較曲折，不像 *Dendrograptus grabaui* 那樣勁直。*Dendrograptus cf. grabaui* Sun 可能與此種筆石更接近。

**層位及產地：**同前一種。

**登記號碼：**7315 a-b（正型標本），7316 a-b（副型標本）。

### *Dendrograptus y-wangi* Mu（新種）

（圖版 VI，圖 1—3）

筆石體爲樹形，高 20 毫米，寬 15 毫米。由一個短的莖生出兩個主枝，兩個主枝之間造成 50° 的角度，從每一主枝的內側各生出 2—3 個簡單的或者複雜的側枝。分枝的距離爲 2—3 毫米，分枝的角比較尖銳。側枝和主枝的寬度相同，在背面看來，寬度約爲 0.5 毫米，在側面看來則稍微增寬，約爲 0.6 毫米。

正胞管爲長管狀，在筆石枝的側面看來，則呈齒形，在 5 毫米的長度中有 5—6 個正胞管，這些胞管相互間掩蓋其長度的  $\frac{1}{2}$ 。副胞管較小，不太清楚。

**比較：**這種筆石和前面剛描述過的 *Dendrograptus suni* 相像，筆石枝也是微有彎曲，胞管的性質也相同；但是筆石枝的分枝情形不同，因而筆石體的形狀也不一樣。此種筆石照筆石體的形狀看，有些像北美洲寒武系中的 *Dendrograptus hallianus* (Prout)，但是，筆石枝的彎曲情形及胞管的性質均不相同。

**層位及產地：**與前一種筆石相同。

**登記號碼：**7317 a-b（正型標本），7318 a-b，7319 a-b（副型標本）。

### *Dendrograptus liaotungensis* Mu（新種）

（圖版 VI，圖 4—8）

這種筆石有好幾個標本，筆石體細長，高度在 30 毫米以上，寬度約爲 10 毫米。莖短而粗，具有一個很小的底盤（附着盤）。筆石枝稍微彎曲，但在筆石體末部的筆石枝顯得勁直；這些枝排列緊密，在 5

毫米的寬度中有 4—6 個枝：筆石枝的寬度在背面保存的筆石枝看來。約為 0.5 毫米，但是側面保存的筆石枝，其寬度大增，為 0.9 毫米。

在側面保存的筆石枝上，胞管呈齒形，胞管陡立，傾斜角很小，即胞管軸向與筆石枝軸向之間交成很小的角度；在 5 毫米的長度中有 10 個胞管，正胞管和副胞管難以區分。

**比較：**由筆石體的形狀看來，此種筆石有些像北美洲寒武紀的一種樹筆石 *Dendrograptus edwardsi* var. *major* Ruedemann，但是胞管的性質不同，同時此種筆石的筆石枝排列得也比較緊密。

**層位及產地：**此種筆石產於遼寧本溪豆房溝及遼陽烟台五頂山的冶里統 *Callograptus? taitzeensis* 帶中，和許多樹形筆石共生。

**登記號碼：**7320—7324（共型標本）。

### *Dendrograptus flexiramis* Mu（新種）

（圖版 VI，圖 15—16）

這種筆石有兩個不完整的標本。其中之一（圖版 VI，圖 15）有一個很短的莖和一個很小的底盤。從莖的末端生出兩個主枝，兩個主枝之間造成  $60^\circ$  的角度：主枝曲折，長 12 毫米，寬 0.3 毫米。僅有這兩個主枝保存下來，所有其他筆石枝在成為化石以前均已斷去。

在另一個標本裏（圖版 VI，圖 16）有 4 個曲折的筆石枝。這些枝從背部看來很細（0.3 毫米），但側面保存的筆石枝其寬加大一倍（0.6 毫米）。這些枝的分枝距離不規則，分枝角度很小。正胞管在側面保存的筆石枝上看得很清楚，呈齒形，具有很尖銳的口尖，腹緣凹入，口緣平，在 5 毫米的長度中有 9 個正胞管。副胞管不清楚。

**比較：**從筆石枝的性質看來，我們這個樹筆石的新種與北美洲 Deepkill 頁岩（下奧陶紀）中的 *Dendrograptus fluitans* Ruedemann 最為接近。但是，筆石體的形狀和胞管的性質都不相同。*Dendrograptus fluitans* 的胞管（大概是正胞管）比較向外伸展，而且排列得比較稀疏。

**層位及產地：**此種筆石產於遼寧本溪縣田師付冶里統 *Callograptus? taitzeensis* 帶中，共生的筆石有 *Dictyonema flexilimosum* Mu（新種），*Reticulograptus yangi* Mu（新種），*Callograptus sinicus* Mu（新種），*C. curvithecalis* Mu（新種）等。

**登記號碼：**7325，7326（共型標本）。

### *Dendrograptus lotolatzensis* Mu（新種）

（圖版 VI，圖 9—14）

此種筆石有 20 多個標本。筆石體為樹形，很小，最大的標本高約 10 毫米，寬 14 毫米；具有兩個或三個主枝，從主枝上再生出側枝，側枝有的簡單有的又行分枝；分枝的距離無定，約為 1—3.5 毫米。主枝及側枝都很細，其寬度不及 0.2 毫米。莖短，始端有一個很小的附着盤。

在筆石枝的背側看不到胞管，在側面保存的筆石枝中可以看到正胞管，這些正胞管很短，呈齒狀，腹緣凸出，在 10 毫米的長度中有 14 個胞管。副胞管的形狀不得而知。

**比較：**在筆石體的形狀上，這種筆石像北美洲 Niagara 燧石層（志留紀）中的 *Dendrograptus ontarioensis* Bassler，但是，我們的這個新種，筆石體比較小，筆石枝比較細，產出的地層層位也低得多（特馬豆克）。由這些很細的筆石枝看來，這種筆石也有些像 Niagara 燧石層中的 *Dendrograptus praegacilis* Spencer，但是，筆石體的形狀和胞管的性質全不相同。從很小的筆石體看來，這種筆石和下面將描述的 *Dendrograptus yini* Mu（新種）最為接近，但是此種筆石比後一種的分枝次數較少，分枝的距離較大。

**層位及產地：**這一新種保存在泥質白雲岩中，產於遼寧本溪駱駝砬子的下平州白雲岩頂部以上 3 公尺處，是冶里統下部筆石帶 *Dendrograptus lotolatzensis* 帶的帶化石。共生的筆石有 *Callograptus* sp. aff. *C. hopkinsoni* Bulman，*Dendrograptus ptilograptoides* Mu，*Inocaulis sinensis* Mu（新種）等。



登記號碼：7327（正型標本），7328—7332（副型標本）。

### *Dendrograptus ptilograptoides* Mu

（圖版 VII，圖 13）

1953. *Dendrograptus ptilograptoides* 穆恩之，古生物學報，第 1 卷第 1 期，頁 30, 35；圖版 I，圖 6。

此種筆石僅有一個相當完整的標本。筆石體為灌木狀，高 25 毫米，寬 15 毫米。莖很短，在莖的始端有一個極小的底盤。主枝稍微彎曲，分枝距離不規則，分枝角度很小。側枝有的簡單不再分枝，也有再行分枝。所有主枝和側枝，其寬度相同，而且始終均一，為 0.45 毫米。

在側面保存的筆石枝中，可以看到很小正胞管，呈鋸齒狀，在 5 毫米的長度中有 7—8 個正胞管。副胞管的性質不明。

**比較：**此種筆石的特徵是從主枝的兩側生出很多側枝，在筆石體的末部這些側枝排列較密，形成羽狀。因這種特性此種筆石容易和其他種樹筆石區別開來。就這種側枝排列的情形來看，這種筆石像是羽筆石（*Ptilograptus*）的一種，但是，並不像羽筆石的側枝排列得那麼規則。這一種可能是代表樹筆石和羽筆石之間的過渡形式。

**層位及產地：**同前一種。

登記號碼：7333 a-b（正型標本）。

### *Dendrograptus hsüi* Mu（新種）

（圖版 VII，圖 1—4）

筆石體細長，高約 20 毫米，寬約 10 毫米，包含很多很細的筆石枝。筆石枝的寬度為 0.2 毫米，這些枝集成幾個組，各組在主枝的兩側左右相互排列，主枝曲折，筆石枝分枝角度起初約為 40°，然後各枝向內轉，分枝間的距離通常為 1.3 毫米或者稍強。

正胞管為細管狀，與枝的軸向之間所成的角度很小，稍微突出，在 10 毫米的長度中有 16—20 個正胞管。副胞管很小，不突出。

**比較：**此一新種的特徵是幾組筆石枝的左右相互排列。此種筆石的不完整標本很像東北治里統的 *Dendrograptus lotolatzensis* Mu（新種）和鄂西宜昌統的 *Dendrograptus yini* Mu（新種）。此種筆石可以用更細的筆石枝及胞管的性質和前者相區別；而以稍微彎曲的筆石枝及很小的分枝距離來與後者相區別。

**層位及產地：**此種筆石產於湖北長陽高家嶺宜昌統 *Acanthograptus sinensis* 帶的上部；共生的筆石有 *Dendrograptus yangtzensis* Mu（新種），*D. yini* Mu（新種），*Acanthograptus macilentus* Hsü，*A. flexilis* Mu（新種）等等。

登記號碼：7334（正型標本），7335, 7336（副型標本）。

### *Dendrograptus yangtzensis* Mu（新種）

（圖版 VII，圖 5—10）

此種筆石僅有一些不太完整的標本。筆石體為灌木狀，其高度為 15 毫米以上，寬約 10 毫米。從一個很短的莖上伸出兩個或多個筆石枝，其中之一成為曲折的主枝，兩側各生出簡單及複雜的側枝。在筆石體的始部筆石枝分枝距離較遠，但在末部則分枝頻繁，分枝距離較近，結果形成很多末枝（terminal branches）。主枝和側枝的寬度相等，約為 0.3 毫米；末枝則比主枝顯得勁直。

由於標本保存得不佳，胞管性質難以觀察，沿着筆石枝偶然可以見到齒狀物，在 2 毫米中有 5 個。正胞管和副胞管不能區分。

**比較：**此種筆石的筆石體像 *Dendrograptus hsüi* Mu（新種），但是此種筆石的主枝更曲折，亦不規則，同時筆石枝的寬度也比較大。

**層位及產地：**同前一種。

登記號碼：7337 (正型標本)，7338—7342 (副型標本)。

### *Dendrograptus yini* Mu (新種)

(圖版 VII, 圖 11—12)

此種筆石有一些保存良好的標本，包括兩個完整的筆石體。筆石體很小，為樹形，通常高度為 10 毫米，寬度與高度大體相等。從一個很短的莖伸出兩個或三個主枝。每一主枝又各分枝 4—5 次，因而形成很多枝。所有這些枝都細微如線，看起來相當勁直；分枝角度約為  $30^\circ$ ，分枝間的距離在筆石體的始部為 2 毫米，但在末部則減至 1 毫米。

胞管稍微突出，在 5 毫米的長度中有 10 個胞管。副胞管難以辨別。

比較：由很小的筆石體和細微的筆石枝看來，此種筆石和東北冶里統的 *Dendrograptus lotolatzensis* Mu (新種) 最為接近，但是，此種筆石分枝比較頻繁，筆石枝也比較勁直。

層位及產地：和 *Dendrograptus hsüi* Mu (新種) 相同。

登記號碼：7343 (正型標本)，7344 (副型標本)。

### *Dendrograptus yini* var. $\alpha$

(圖版 VIII, 圖 1)

此種筆石在主要性質上和 *Dendrograptus yini* Mu (新種) 相同，僅筆石體略小，筆石枝較細，而且比較彎曲。

層位及產地：湖北長陽柑子坪宜昌統，與 *Dendrograptus hupehensis* Mu (新種) 共生。

登記號碼：7345 (正型標本)。

### *Dendrograptus yini* var. $\beta$

(圖版 VIII, 圖 2—3)

此種筆石在主要性質上也和 *Dendrograptus yini* 相同，僅筆石體更小，分枝次數更頻繁。

層位及產地：湖北長陽多寶寺宜昌統 *Acanthograptus sinensis* 帶。

登記號碼：7346 (正型標本)，7347 (副型標本)。

### *Dendrograptus hupehensis* Mu (新種)

(圖版 VIII, 圖 4—5)

筆石體很小，細長，高 12 毫米，寬僅 2 毫米許。有一個主枝，側枝很少，這些側枝大致都是從主枝的一側生出的，主枝和側枝都很細，寬約 0.2 毫米，筆石枝直，分枝的角度很小，僅  $20^\circ$  或稍強，分枝的距離為 1—3 毫米。

正胞管細長，在 5 毫米中有 11 個正胞管。胞管陡立，即胞管軸向與枝的軸向之間造成極小的角度，稍微突出，在筆石枝的側面呈齒狀。副胞管很小，不突出。

比較：就細小的筆石枝和很小的分枝角度來看，這種筆石很像北美洲 Deepkill 頁岩中的 *Dendrograptus gracilimus* Ruedemann，但是我們這個新種的筆石枝分枝距離大，分枝次數少；胞管排列亦較稀疏。這種筆石可以用筆石體的形狀和其他細小的樹筆石相區別。

層位及產地：湖北長陽柑子坪宜昌統的 *Acanthograptus sinensis* 帶。

登記號碼：7348 a-b (正型標本)。

### 羽筆石屬 (*Ptilograptus* Hall, 1865)

#### *Ptilograptus glomeratus* var. *sinicus* Mu (新變種)

(圖版 VIII, 圖 6—8)

此種筆石有兩個標本，其中之一是比較完整的，即正型標本 (圖版 VIII, 圖 6—7)。筆石體很小，不完整，長約 15 毫米，寬度不及 10 毫米，主枝又以正分枝方式分成兩個主枝，兩主枝間造成  $60^\circ$  的角



度：所有這些主枝的兩側都具有相互排列的側枝，呈羽毛形，側枝相互平行，長 1—2.5 毫米，與主枝之間造成  $50—60^\circ$  的角度：在 5 毫米的長度中，主枝的每一側有 7 個側枝。主枝和側枝都很細，約 0.2—0.3 毫米，主枝比側枝稍寬。

另一標本，即副型標本（圖版 VIII，圖 8），僅有一個主枝，側枝很短，長僅 0.8 毫米，與主枝所交的角度為  $30—40^\circ$ ，在 5 毫米的長度中，主枝每側有 7 個側枝。這個標本大概祇是一個筆石體的末部。

胞管並不伸出枝外，詳細構造不明。

**比較：**從筆石體的形狀和筆石枝的分枝情形看來，這一筆石和捷克波希米亞的 *Ptilograptus glomeratus* Pořta 最為接近，所不同的僅僅是我們這種標本側枝的排列比較緊密。不幸的是筆者無法獲得參閱 Pořta 的原著，只能和 Bulman (1938, 頁 D 19, 圖 13 d—e) 所抄該種筆石的圖像來作比較。

Hopkinson (1895) 根據羽筆石 (*Ptilograptus*) 的羽狀側枝，創立羽筆石科 (*Ptilograptidae*)，據 Ruedemann (1947) 所描述羽筆石的情形看來，羽筆石的胞管性質和樹筆石相同，況且有些樹筆石如上面描述過的 *Dendrograptus ptilograptoides* Mu (新種) 也是主枝兩邊具有側枝，而側枝有時也作羽狀排列如同羽筆石。因此，筆者 (1953) 認為羽筆石一屬，包括在樹筆石科的樹筆石亞科中比較單獨成立一科更為合適。

**層位及產地：**此種筆石產於四川華蓥山艾家山統（中奧陶紀）中，與 *Dictyonema szechuanense* Mu (新種) 共生。

登記號碼：7349 (正型標本)，7350 a-b (副型標本)。

### 刺筆石科 (*Acanthograptidae* Bulman, 1938)

#### 刺筆石屬 (*Acanthograptus* Spencer, 1878)

#### *Acanthograptus sinensis* Hsü

(圖版 VIII, 圖 14)

1948. *Acanthograptus sinensis*, 許傑, 中央研究院地質研究所叢刊第 8 號, 頁 13—14, 圖版 I, 圖 5a—b; 圖版 II, 圖 1, 2a—b, 3, 5a—b.

在我們的材料中有幾個不完整標本被鑑定為此種筆石。筆石枝較粗大，寬度約為 1.5—2 毫米（芽枝不計算在內）；芽枝通常較長，長度為 1—1.5 毫米，與筆石枝交成  $50—75^\circ$  的角度，在 10 毫米的長度中枝的兩側各有芽枝 11—13 個。關於此種筆石的詳細描述，讀者可以參看許傑教授的著作 (1948)。

**層位及產地：**此種筆石是揚子峽區宜昌統 *Acanthograptus sinensis* 帶的帶化石。本文所描述的材料係採自湖北長陽柑子坪宜昌統上部，共生的筆石有 *Dictyonema asiaticum* Hsü, *Callograptus yangtzensis* Mu (新種) 等。

登記號碼：7351 a-b (近型標本)。

#### *Acanthograptus flexiramiatus* Hsü

(圖版 VIII, 圖 17)

1948. *Acanthograptus flexiramiatus*, 許傑, 中央研究院地質研究所叢刊第 8 號, 頁 17—18, 圖版 IV, 圖 3a—b.

有一個破碎的標本可以和此種筆石相比。筆石枝微彎，具有一個短的側枝，分枝角度為  $30^\circ$ 。筆石枝的寬度上下均一，為 0.8 毫米（芽枝不計算在內）。芽枝的長度為 0.8—1 毫米，在 5 毫米的長度中，枝的兩側各有芽枝 7—8 個。

**層位及產地：**同前一種。

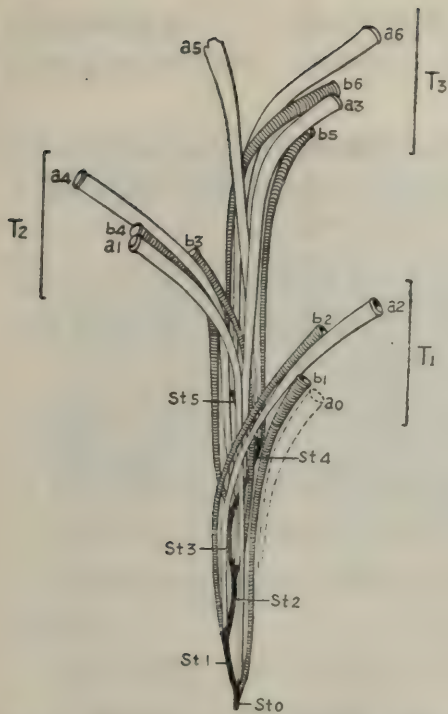


圖 11 *Acanthograptus succicus* (Wiman), 示胞管的組合情形，兩個正胞管和兩個副胞管組成一個芽枝。參照 Bulman, 1938, 予以增補。a, 正胞管; b, 副胞管; st, 莖胞管; T, 芽枝。

登記號碼: 7352 a-b (近型標本)。

### *Acanthograptus bifurcus* Hsü

(圖版 VIII, 圖 9)

1948. *Acanthograptus bifurcus*, 許傑, 中央研究院地質研究所叢刊第 8 號, 頁 16, 圖 III, 圖 2a-b, 3a-b.

此種筆石祇有一個不完整的標本。筆石枝的寬度均一，約為 0.7 毫米 (芽枝不計算在內)，正分枝，分枝角度為  $70^\circ$ ，胞管為細長的管狀，幾個胞管組成短的芽枝。芽枝外形似刺，長 0.5 毫米，在筆石枝的兩側左右相互排列，在 5 毫米的長度中有芽枝 7 個。

層位及產地：同前一種。

登記號碼：7353 (近型標本)。

### *Acanthograptus macilentus* Hsü

(圖版 VIII, 10-13)

1948. *Acanthograptus macilentus*, 許傑, 中央研究院地質研究所叢刊, 第 8 號, 頁 15-16, 圖版 II, 圖 4, 8a-b, 9a-b; 圖版 III, 圖 1a-b.

筆石體小，通常為 15—20 毫米長，10 毫米寬，包含一個主枝和一些側枝：這些側枝由主枝的兩側生出，但不規則；所有主枝和側枝都顯得勁直，其寬度約為 0.7 毫米 (芽枝不計算在內)。芽枝長 0.9 毫米，在枝的 5 毫米長度中，每側有 6—7 個芽枝。

層位及產地：此種筆石產於湖北長陽高家嶺、宜昌統 *Acanthograptus* 帶的上部，與它共生的筆石有 *Dendrograptus hsüi* Mu (新種)，*D. yini* Mu (新種)，*D. yangtzensis* Mu (新種)，*Acanthograptus flexilis* Mu (新種)，*A. rigidus* Hsü, *A. intermedius* Mu (新種) 等等。

登記號碼：7354—7357 (近型標本)。

### *Acanthograptus rigidus* Hsü

(圖版 VIII, 圖 15-16)

1948. *Acanthograptus rigidus*, 許傑, 中央研究院地質研究所叢刊, 第 8 號, 頁 18, 圖版 IV, 圖 4a-b.

筆石體細小，包括一個主枝及一些側枝，主枝和側枝都很細，看起來都很勁直，寬度均一，恆為 0.4 毫米 (芽枝不計算在內)。芽枝短，長僅 0.3—0.4 毫米，在 5 毫米的長度中有 5 個芽枝。

層位及產地：與前一種相同。

登記號碼：7358 a-b, 7359 a-b (近型標本)。

### *Acanthograptus flexilis* Mu (新種)

(圖版 IX, 圖 1-2)

此種筆石有好幾個標本。筆石體很小，長度在 10 毫米以上，寬度不及 10 毫米。具有一個極其曲折的主枝和一些側枝。這些側枝生於主枝的兩側排列的距離不規則。主枝和側枝都很細，寬度為 0.4—0.5 毫米 (芽枝不計算在內)。芽枝長 0.9 毫米，在 5 毫米的長度中有 9 個芽枝。



**比較：**就筆石體的體積及筆石枝的分枝情形來講，此種筆石與 *Acanthograptus macilentus* Hsü 及 *A. rigidus* Hsü 最為接近，但以此種筆石的強度彎曲的筆石枝及其緊密排列的芽枝，容易和那兩種筆石區別開來。

**層位及產地：**湖北長陽高家嶺及柑子坪的宜昌統 *Acanthograptus sinensis* 帶。

**登記號碼：**7360, 7361 (共型標本)。

### *Acanthograptus intermedius* Mu (新種)

(圖版 IX, 圖 3)

筆石體為灌木狀，很小，長僅 10 毫米，寬度與長度大約相當。從一個短的莖上伸出幾個筆石枝，分枝的角度很小。中間一枝又連續分枝，有的正分，有的側分。所有筆石枝都是直的，具有均勻的寬度，約為 0.4 毫米；但在枝的腹部看來，稍微細些。芽枝長 0.6 毫米，在 5 毫米的長度中有 5 個芽枝。

**比較：**由很小的筆石體和細長的筆石枝看來，此種筆石和 *Acanthograptus macilentus* Hsü 及 *A. rigidus* Hsü 相似，但是筆石體的形狀及筆石枝分枝的方式均不相同。從筆石枝正分枝的情形看來，此種筆石很像 *Acanthograptus bifurcus* Hsü，但以此種筆石的細小的筆石體及細而直的筆石枝很容易和該種區別。

**層位及產地：**與前一種相同。

**登記號碼：**7362 (正型標本)。

### 帚筆石屬 (*Coremagraptus* Bulman, 1927)

#### *Coremagraptus?* sp.

(圖版 IX, 圖 4)

因為標本不完整，筆石體的形狀不得而知。這種不完整的標本很小，長 6 毫米，寬 3.5 毫米。筆石枝彎曲，仔細看來，極其曲折，不計算芽枝在內的寬度為 0.3—0.4 毫米。這些枝間偶然似有絞結相連結，芽枝稍微伸出，在 5 毫米的長度中有 5—7 個芽枝。筆石枝的分枝方式以側分為主，在筆石體的末部偶然也有正分枝。胞管的性質和刺筆石 (*Acanthograptus*) 相同。

**比較：**此種筆石像是刺筆石的一種，但是具有波狀彎曲的筆石枝。從波狀的筆石枝及絞結看來，此種筆石應當是帚筆石但是標本破碎仍難作確切的鑑定。

**層位及產地：**湖北長陽柑子坪宜昌統 *Acanthograptus sinensis* 帶。

**登記號碼：**7363 a-b (正型標本)。

### 毛莖筆石科 (*Inocaulidae* Ruedemann, 1947)

#### 毛莖筆石屬 (*Inocaulis* Hall, 1851)

#### *Inocaulis sinensis* Mu (新種)

(圖版 IX, 圖 5)

筆石體僅有一個直的筆石枝，長 14 毫米，寬 0.5 毫米（突出的胞管不計算在內）；始部較細，向末端逐漸變寬；最大的寬度（0.5 毫米）在靠近末端處。胞管細長，但頗勁直，伸出枝外，與枝間造成約 20° 的角度。

**比較：**此種筆石和刺筆石一樣，也是胞管伸出枝外。但是，刺筆石是幾個胞管組成一個芽枝，而此種筆石的胞管末部則是彼此獨立的。一個筆石枝包含很多細微的胞管，胞管末部伸出，各自獨立，如同毛髮，這些正是毛莖筆石屬的屬性。因此，此種筆石應當是毛莖筆石的一種。我們這個新種的筆石體比較特殊，胞管比較勁直，易與其他毛莖筆石相區別。

**層位及產地：**遼寧本溪駱駝砬子冶里統下部 *Dendrograptus lotolatzensis* 帶，共生的筆石有 *Dendrograptus lotolatzensis* Mu (新種)，*D. Ptilograptoides* Mu (新種)等。

登記號碼：7364（正型標本）。

*Inocaulis?* sp. A.

（圖版 IX，圖 8—9）

筆石體長，其長度約為 30 毫米，寬度僅數毫米，包含幾個彎曲的筆石枝。筆石枝的分枝角度很小，分枝距離較長，所有筆石枝的寬度大致相同，約為 1.4 毫米；枝的兩邊平行而且邊緣光滑。胞管的痕跡偶然可以見到，它們互相平行，擠在一起，並不伸出枝外，詳細情形不明。

比較：由筆石體及筆石枝的形狀看來，此種筆石很像北美洲奧陶紀的 *Inocaulis simplex* Ruedemann。但是該種筆石的胞管稍微突出，而我們的這種筆石的胞管並不突出。胞管不伸出枝外的是否仍然屬於毛莖筆石尚成問題，故於屬名之後加一問號，表示存疑。

層位及產地：遼寧本溪縣田師付溝治里統 *Callograptus? taitzeoensis* 帶。

登記號碼：7365（正型標本），7366（副型標本）。

*Inocaulis?* sp. B.

（圖版 IX，圖 6—7）

此種筆石在主要的性質上和前一種相同，所不同的，是此種筆石的筆石枝比較勁直，而且是正分枝。

層位及產地：遼寧省本溪縣田師付及遼陽縣五頂山的治里統。

登記號碼：7367（正型標本），7368（副型標本）。

反稱筆石科 (*Anisograptidae* Bulman, 1950)

反稱筆石屬 (*Anisograptus* Ruedemann, 1937)

*Anisograptus lui* Mu

（圖版 IX，圖 14—15）

1953. *Anisograptus lui*, 穆恩之, 古生物學報, 第 1 卷, 第 1 期, 頁 30, 35; 版圖 I, 圖 5.

此種筆石有一個不太完整的筆石體和一些零碎的筆石枝。筆石體呈盤狀，直徑為 80 毫米，包含 20 多個末枝。筆石體中心有一個小的突起，表示胎胞管的所在。從胎胞管伸出三個短而粗（長 1 毫米）的原始枝，每一原始枝正分枝分成兩個次級枝，次級枝長 2.5 毫米，寬 1.2 毫米；所有這些次級枝又各再正分若干次。三級枝的寬度相同，但長度不等，可以分作兩組：一組長度為 3 毫米，而另一組則為 6.5 毫米。四級枝也分為兩組：一組的長度為 7.5 毫米，另一組則為 8 毫米。五級枝則分別為 9 毫米及 10 毫米以上。所有這些枝全是平伸展，具有很微弱的彎曲。

從另一標本（圖版 IX，圖 15）側面保存的筆石枝裏，我們可以得出胞管的性質如下：

正胞管非常細長，與枝的軸向造成極小的角度；正胞管長 1.2 毫米，長度約當寬度的 4 倍，掩蓋其長度的  $\frac{1}{4}$ — $\frac{1}{2}$ ，在 10 毫米的長度中有 12—13 個正胞管。副胞管較小。

比較：從筆石體的形狀上和筆石枝的分枝方式上看來，此種筆石與 *Anisograptus richardsoni* Bulman (1941, 圖版 II, 圖 6) 最為接近，但是此種筆石的筆石體較大，原始枝較短，此其不同之點。驟然看來，此種筆石很像歐洲的 *Clonograptus tenellus* var. *calavei* Elles et Wood (1902, 圖版 XI, 圖 3 a—b)，但是我們這種筆石有三個原始枝，而歐洲的那種筆石只有兩個原始枝。三個原始枝是反稱筆石 (*Anisograptus*) 的主要特徵之一。

層位及產地：此種筆石產於遼寧省遼陽縣烟台五頂山治里統的 *Callograptus? taitzeoensis* 帶中，共生的筆石有 *Dictyonema flexiliramosum* Mu (新種)，*Callograptus? taitzeoensis* Mu, *Bryograptus yentaiensis* Mu (新種) 等。



登記號碼：7369 a-b (正型標本)，7370 (副型標本)。

***Anisograptus cf. matanensis* var. *tetragraptoides* Bulman**

(圖版 IX, 圖 16; 插圖 13)

Cf. 1950. *Anisograptus matanensis* var. *tetragraptoides*, Bulman, Quart. Journ. Geol. Soc. London, 卷 106, 頁 83—84, 圖版 VII, 圖 14—17; 圖版 VIII, 圖 4, 11; 插圖 4h.

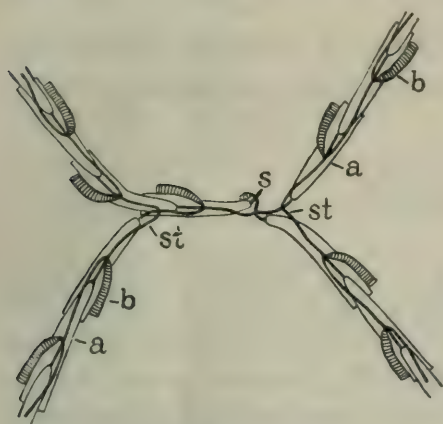


圖 12 示反稱筆石筆石體始部的構造，參照 Bulman, 1950, 予以簡化。s, 胎胞管；a, 正胞管；b, 副胞管；st, 莖胞管。

筆石體很小，平伸，直徑約為 10 毫米(可能不完整)。包含 4 個筆石枝，外形像是四筆石 (*Tetragraptus*) 的一種。從胎胞管伸出 3 個原始枝，其中之一在距離胎胞管很近處 (1 毫米稍強) 又分成兩枝，其餘兩個原始枝則始終未再分枝。所有這些枝都是平伸展開，看起來都很勁直，其寬度約為 0.4 毫米。筆石枝的側面形狀不得知，枝上僅見胞管的形像(可能是正胞管)，在 5 毫米中約有 5—6 個胞管。

比較：除筆石體的體積較小以外，我們這個標本的其他性質和加拿大 Matane 頁岩 (特馬豆克期) 中的 *Anisograptus matanensis* var. *tetragraptoides* Bulman 相同。

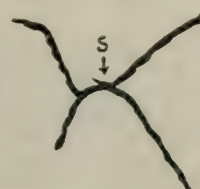


圖 13 *Anisograptus cf. matanensis* var. *tetragraptoides* Bulman, 放大×3, 同圖版 IX, 圖 16, 示三個原始枝從胎胞管伸出的情形，S 指胎胞管。

我們這個標本如非不完整的成年標本，即為一幼年標本。在普通的筆石體形像看來，此種筆石和四筆石相似，但是，此種筆石有三個原始枝，而四筆石僅有兩個原始枝；況且四筆石為正筆石，而此筆石則為樹形筆石。

**層位及產地：**此種筆石產於浙江省江山縣大陳南焦印渚埠頁岩(特馬豆克期)的 *Clonograptus-Triarthrus* 帶中，共生的筆石有 *Clonograptus tenellus* var. *calavei* Elles et Wood, *Adelograptus asiaticus* Mu (新種)及 *Didymograptus*? 等。

登記號碼：7371 a-b (近型標本)。

**苔蘚筆石屬 (*Bryograptus* Lapworth, 1880, Bulman 1941 修正)**

***Bryograptus yentaiensis* Mu (新種)**

(圖版 IX, 圖 17—18)

此種筆石有兩個標本，其中有一個是比較完整的。筆石體下垂，很小，高 9 毫米，寬 7 毫米(末部)。三個原始枝各再正分三次以上，分枝距離約為 2 毫米，由於各枝的分枝距離相當，造成分枝帶。所有筆石枝都很細，寬約 0.2 毫米。這些枝大致互相平行，稍微彎曲。在筆石體的末部 5 毫米的寬度中有 11 個枝。正胞管細小，稍微突出，在 5 毫米的長度中有 9 個正胞管。副胞管不清楚，僅見痕跡。

上面的描述係根據正型標本(圖版 IX, 圖 17)。在另一標本即副型標本(圖版 IX, 圖 18)裏，胎胞管非常清楚，胎胞管的長度約為 1 毫米，在胎胞管的頂端有一個很小的浮盤，其直徑僅 0.5 毫米。從胎胞管下垂伸出三個原始枝，其中一枝在末端已經斷去，其餘兩枝各又正分若干次。

比較：從筆石體的形狀及筆石枝的分枝方式看來，此種筆石和加拿大 Matane 頁岩中的 *Bryograptus patens* Matthew (Bulman, 1950) 最為接近，但是，此種筆石的筆石體很小，易於區別。由筆石枝的正分枝、大致平行、及緊密排列等性質來看，此種筆石很像 *Callograptus? taitzehoensis* Mu，但是，此種筆石的筆石體為下垂伸展，而且具有顯著的胎胞管，此其不同之點。

苔蘚筆石 (*Bryograptus*) 一屬以前被認為是屬於正筆石目的筆石。在 1950 年 Bulman 根據此屬的筆石枝具有樹形筆石的構造,即具有正胞管及副胞管等,遂將此屬從正筆石目移入樹形筆石目中。可是,此屬的屬型 *Bryograptus kjerulfi* Lapworth 究竟是正筆石還是樹形筆石,仍然是尚未解決的問題。因此, Bulman 用一問號將此屬放在反稱筆石科裏。無論如何,我們這一新種和 *Bryograptus patens* Matthew 以及下面將描述的 *Bryograptus chekiangensis* Mu (新種)應為樹形筆石。假若苔蘚筆石的屬型是正筆石的話,那末,上述這幾種苔蘚筆石必須代表樹形筆石目中的一個新屬。

**層位及產地:** 此種筆石產於遼寧遼陽烟台五頂山冶里統的 *Callograptus? taitzeensis* 帶中,共生的筆石有: *Dictyonema flexiliramosum* Mu (新種), *Callograptus? taitzeensis* Mu, *Anisograptus lui* Mu 等。

**登記號碼:** 7372 (正型標本), 7373 (副型標本)。

### ***Bryograptus chekiangensis* Mu (新種)**

(圖版 X, 圖 1—3)

筆石體下垂,體積中等,長約 27 毫米,寬約 12 毫米。筆石枝寬 0.4 毫米,為正分枝,分枝距離規則,為 5—10 毫米,形成分枝帶。由於標本保存不佳,胞管性質不甚清楚,僅偶有少數細長胞管可以看到。

**比較:** 從筆石枝的分枝方式看來,此種筆石像加拿大 Matane 頁岩中的 *Bryograptus patens* Matthew 和上面描述過的 *Bryograptus yentaiensis* Mu (新種),但是此種筆石的筆石體的體積及其形狀和那兩種筆石均不相同。由一般的形像看來,此種筆石像是挪威 *Dictyonema* 頁岩(特馬豆克期)中的 *Dictyonema flabelliforme* var. *bryograptoides* Bulman, 但是,該種尚有少許橫靶存留,而我們這種筆石已經完全沒有橫靶。此種筆石可能是從 *Dictyonema* 由於橫靶的消失變來的。

**層位及產地:** 此種筆石產於浙江江山縣黃泥崗印渚埠頁岩的 *Clonograptus — Triarthrus* 帶中,與 *Adelograptus sinicus* Mu (新種)及 *Didymograptus?* 等筆石共生。

**登記號碼:** 7374 (正型標本)。

### ***Bryograptus? shengi* Mu (新種)**

(圖版 IX, 圖 10—13)

筆石體很小,呈鈴狀,長 6.5 毫米,寬 5.5 毫米。從筆石體的始端伸出三個原始枝,各枝先下斜伸展然後向下垂伸,大部分相互平行,每一主枝具有 2—3 個側枝,這些側枝或簡單或再行分枝。主枝和側枝都很細微,寬約 0.2 毫米,各枝緊密排列,在 10 毫米的寬度中有 9—10 個枝。

上面的描述係根據正型標本(圖版 IX, 圖 10—11)。在另一標本即副型標本裏(圖版 IX, 圖 12—13),胎胞管很清楚,在胎胞管的尖端有一小而複雜的浮盤。第一個胞管似乎是從胎胞管的頂部可能是原胎管(*proscicula*)生出。根據此一標本中的側面保存的筆石枝,得出胞管的性質如下:

正胞管很小,側面輪廓像鋸齒,腹緣凸出,口緣凹入,形成尖銳的口尖。各個相鄰正胞管之間,掩蓋其長度的  $\frac{1}{2}$  或稍強,在 5 毫米的長度中有 8—9 個正胞管。副胞管存在,但由於標本保存不佳,詳細情況不清楚。

**比較:** 就筆石體的形狀及大小看來,此種筆石很像英國特馬豆克層中被 Elles 及 Wood 所描述為 *Bryograptus kjerulfi* Lapworth 的標本,但是,我們這種筆石的胞管排列得較密,筆石枝較細。由筆石體始端的複雜構造以及筆石枝的排列情況看來,此種筆石很像網筆石的一種,可是,在此種筆石裏尚未見到顯著的橫靶。這種筆石究竟屬於何“屬”,須待將來獲得更好的標本,方可確定;此處暫時用一問號置於苔蘚筆石屬名之下。



登記號碼：7375 a-b (正型標本)，7376 a-b (副型標本)。

### 枝筆石屬 (*Clonograptus* Hall et Nicholson, 1873)

#### *Clonograptus tenellus* var. *calavei* Elles et Wood

(圖版 X, 圖 9—13; 插圖 14)

1902. *Clonograptus tenellus* var. *calavei*, Elles & Wood, Monogr. British graptolites Pal. Soc. London, 頁 84, 圖版 XI, 圖 3a-c.

1909. *Clonograptus tenellus* var. *calavei*, Westergard, Lunds Univ. Arssler. 卷 II, 第 5 冊第 3 號, 頁 69, 圖版 IV, 圖 1—13; 圖版 V, 圖 2.

1922. *Clonograptus tenellus* var. *calavei* Poulsen, Danmarks Geol. Unders., IV, 1, 16, 頁 11, 圖 7—9.

1925. *Clonograptus tenellus* var. *calavei* Monsen, Norsk Geol. Tidsskr., VIII, 頁 158, 圖版 I, 圖 4—6.

筆石體平伸,兩邊對稱,直徑約為 55 毫米。兩個很短的原始枝造成中央粗而短的橫管,每個原始枝各再正分到 5 次,形成 24 個以上的末枝,分枝距離向末端逐漸增加。所有筆石枝全是向外平伸,顯得勁直,稍微有點彎曲,其寬度約為 0.8 毫米。我們的這些標本由於擠壓,多少有點變形,在斜壓的標本裏(圖版 X, 圖 10—12),各枝的分枝距離顯得無規則,但在側面擠壓的標本裏(圖版 X, 圖 9),筆石枝分枝的距離比較規則。

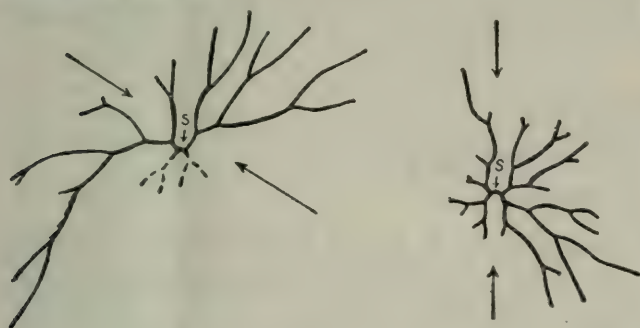


圖 14 *Clonograptus tenellus* var. *calavei* Elles et Wood, 原大同圖版 X, 圖 10 及 9, 示筆石體的變形。圖中箭頭指擠壓的方向, s 指胎胞管的位置。

由於筆石枝水平伸展,常保存為背面,胞管不易看到。但在斜側保存的末枝上,偶然可以見到胞管,這些胞管是細長的管,具有尖銳的口尖。在一些相伴產出的筆石枝上(這些枝大概是屬於此種筆石的),可以看到胞管的側面輪廓,正胞管呈齒狀,具有尖銳的口尖,在 10 毫米的長度中有 10 個胞管。副胞管存在,但不清楚。

**比較：**此種筆石在主要性質上完全和歐洲的 *Clonograptus tenellus* var. *calavei* Elles et Wood 相同,僅胞管的排列稍密。從筆石體的外形上看,此種筆石很像北美洲的 *Clonograptus flexilis*

(Hall) 及 *C. rigidus* (Hall), 但是北美洲的兩種筆石的胞管沒有顯著的口尖。

枝筆石 (*Clonograptus*) 也和苔蘚筆石一樣,從前被認為是正筆石, Bulman 於 1950 年將它從正筆石目移到樹筆石目中,它的屬型 *C. flexilis* 是否有副胞管存在,也就是說是否是屬於樹形筆石目,也未決定。Bulman 附加一問號置於樹形筆石目中的反稱筆石科中。但無論如何,現在所討論的此一筆石 *Clonograptus tenellus* var. *calavei* 為樹形筆石的一種,是沒有疑問的。

此種筆石是歐洲(英國和瑞典)特馬豆克期常見的標準化石之一,但是尚未見有反稱筆石和它共生。相反的,在北美洲東部及西北歐的挪威均有反稱筆石出現,而無或極少枝筆石。Bulman 認為挪威和北美東部應屬於一個筆石動物羣的亞區。因此,此種筆石和反稱筆石同時在中國浙江出現是很有意義的,這種事實表示着浙江屬於另一不同的筆石動物羣區。

**層位及產地：**此種筆石產於浙江省江山縣南焦附近印渚埠頁岩的 *Clonograptus-Triarthrus* 帶中,共生的筆石有 *Anisograptus* cf. *matanensis tetragraptoides* Bulman, *Adelograptus asiaticus* Mu (新種), *Didymograptus*? 等。許傑教授在皖南的譚家橋頁岩中也曾獲得此種筆石(地質學會誌 15 卷, 105 頁)。

登記號碼：7377—7379（近型標本）。

### 匿筆石屬 (*Adelograptus* Bulman, 1941)

#### *Adelograptus asiaticus* Mu (新種)

(圖版 X, 圖 4—7)

此種筆石有不少標本，有些是不完整的筆石體，有些是幼年的標本。筆石體近乎下垂，很小，長度僅為 4.5 毫米，寬度與長度大致相當。胎胞管清楚，為寬而短的圓錐體（長 1 毫米，寬 0.4 毫米）。從胎胞管生出兩個原始枝，其分散角約為  $90^\circ$ ，在距離胎胞管不遠處又各生出側枝，此種側枝有的又行分枝。主枝和側枝的寬度相同，稍微彎曲，在側面看來為 0.6 毫米（經過胞管口部量起），但是從枝的背面看來，其寬度大為減少，僅為 0.2—0.3 毫米。

胞管（可能是正胞管）為寬而短的直管狀，腹緣凹入，口緣平，形成頗尖的口尖，其長度約為 1 毫米，長度等於寬度的 3 倍，相鄰胞管間掩蓋其長度的  $\frac{1}{2}$ ，在 5 毫米的長度中約有 17 個正胞管。副胞管及莖胞管不易區別開來。

**比較：**此種筆石在外形上很像匿筆石的屬型 *Adelograptus hunnebergensis* (Moberg)，但是，後者的主枝近於平伸，而且胞管的排列也比較稀疏。此種筆石的外形也像澳洲 Lancefield 層（特馬豆克期）中的 *Adelograptus victoriae* T. S. Hall，但筆石枝的寬度較大。

**層位及產地：**此種筆石產於浙江省江山縣大陳南焦附近印渚埠頁岩的 *Clonograptus*—*Triarthrus* 帶中，與 *Clonograptus tenellus* var. *calavei* Elles et Wood, *Anisograptus* cf. *matanensis* var. *tetragraptoides* Bulman 等筆石共生。

登記號碼：7380（正型標本），7381—7383（副型標本）。

#### *Adelograptus sinicus* Mu (新種)

(圖版 X, 圖 8)

筆石體下斜生長，胎胞管清楚，為細而長的圓錐形，長度約 1.3 毫米，寬度不及 0.3 毫米。從胎胞管的近口處生出兩個原始枝，兩枝間造成  $100^\circ$  的分散角，其中一枝末部斷去，而另一枝則在離胎胞管 1 毫米左右，由腹部生出一個側枝，側枝又行分枝；筆石枝細，稍微彎曲，其長度不及 5 毫米，側面寬度為 0.3 毫米。主枝與側枝的寬度相當。

胞管細長，長約 1.7 毫米，長度相當寬度的 6—7 倍，腹緣凹入，口緣微凹，形成尖銳的口尖。相鄰胞管間掩蓋胞管長度的  $\frac{1}{3}$ ，在 5 毫米的長度中有 4—5 個胞管。正胞管、副胞管及莖胞管不易區別。

**比較：**此種筆石在筆石體的外形上看最像英國的 *Adelograptus divergens* (Elles et Wood)，但是，胞管的性質差別很遠。我們這一新種的胞管細長，排列較疏，同時筆石枝也比較細。此種和 *Adelograptus asiaticus* Mu (新種) 之間的差別，也是在於胞管的細長和排列稀疏。同樣情形也可以用此種性質和筆石體相似的其他匿筆石如歐洲的 *Adelograptus hunnebergensis* (Moberg) 及澳洲的 *Adelograptus victoriae* T. S. Hall 等相區別。

Ruedemann 曾經描述過北美洲 Deepkill 頁岩中的幾種匿筆石，但誤作苔蘚筆石，如 *Adelograptus kirki* (Ruedemann), *A. lapworthi* (Ruedemann) 等，由這些筆石具有兩個原始枝來看，顯然是匿筆石，而非苔蘚筆石。這些匿筆石和我們的新種相比，單用筆石體的形狀，即可區別開來。有趣的是這兩種北美洲的匿筆石和澳洲的 *Zygograptus irregularis* Harris et Thomas 非常相似。筆者以為所謂“Graptodendroids”可能限於特馬豆克期，Arenigian 及其以後的所謂苔蘚筆石、匿筆石等的種族，可能全是正筆石。

**層位及產地：**此種筆石產於浙江西部江山縣黃泥崗的印渚埠頁岩（特馬豆克期）*Clonograptus*—*Triarthrus* 帶中，和 *Bryograptus chekiangensis* Mu (新種)，*Didymograptus*? 等共生。

登記號碼：7384（正型標本）。



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## 圖 版 說 明

## 圖 版 I

1-4. *Dictyonema wutingshanense* sp. nov.

1. 比較完整的筆石體, 正型標本 (holotype), 原大 ( $\times 1$ ); 遼寧遼陽烟台五頂山上寒武紀鳳山統。登記號碼: 7258a。
2. 同上標本放大 ( $\times 3$ )。
3. 另一幼年標本, 副型標本 (paratype), 放大 ( $\times 5$ ), 示胎胞管及浮盤, 地點同上。登記號碼: 7259a。
4. 枝的一段, 副型標本, 放大 ( $\times 5$ ), 示胞管側面的輪廓。地點同上。登記號碼: 7261。

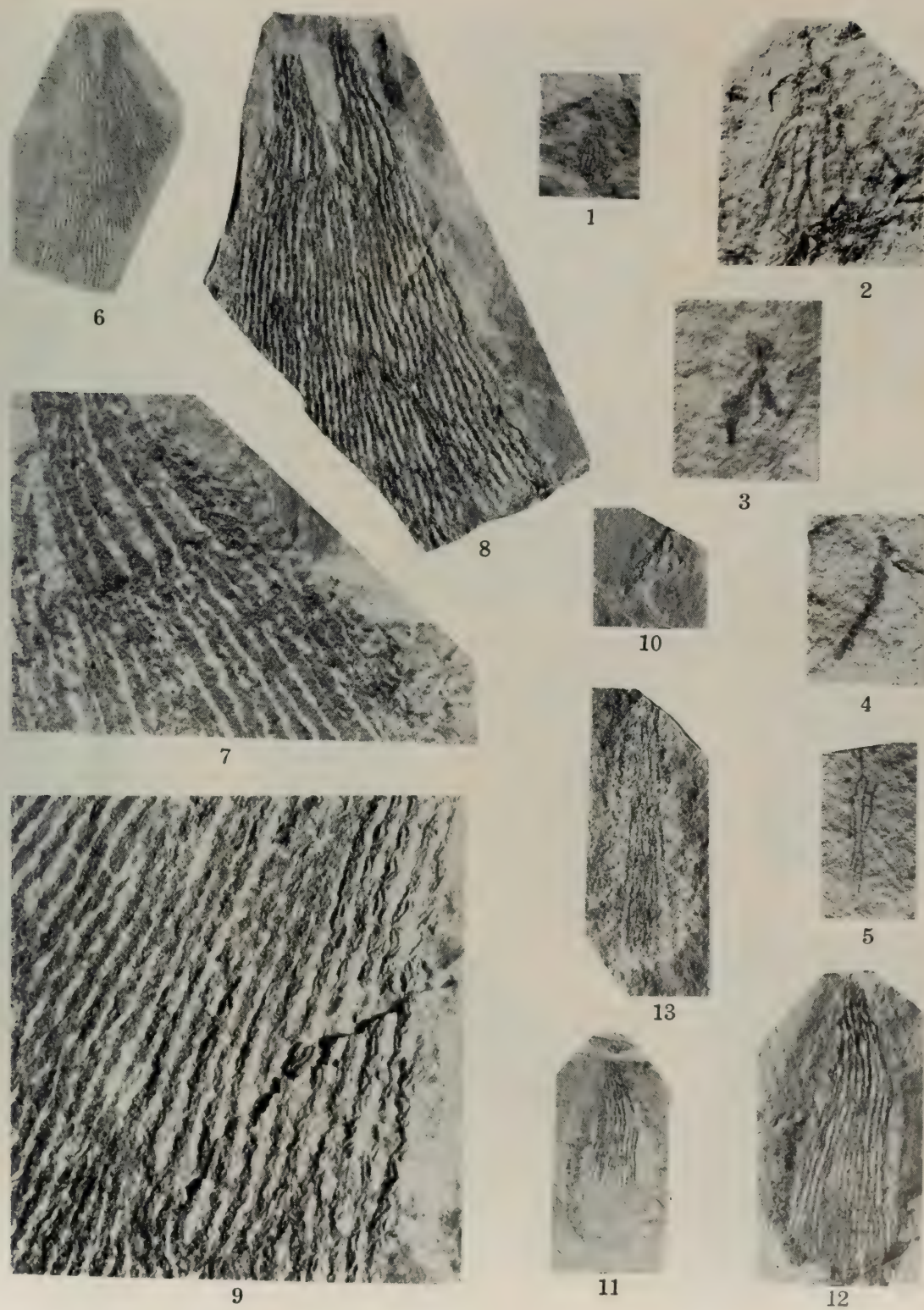
5. *Dictyonema* sp. 原大 ( $\times 1$ ), 內蒙古清水河縣黃河岸, 上寒武紀鳳山統。登記號碼: 7262 (正型標本)。6-10. *Dictyonema flabelliforme* var. *liaotungense* Mu

6. 比較完整的筆石體, 正型標本, 原大 ( $\times 1$ ), 遼寧本溪駱駝砬子下奧陶紀治里統。登記號碼: 7263a。
7. 同上標本的一部分, 放大 ( $\times 5$ ), 示胞管側面的形狀及筆石枝的分枝帶。
8. 同上標本的反對面, (counterpart), 放大 ( $\times 2$ )。登記號碼: 7263b。
9. 同上標本的一部分, 放大 ( $\times 5$ ), 示胞管在筆石枝背面保存的情況。
10. 另一幼年的標本始部, 放大 ( $\times 2$ ), 副型標本, 產地同上。登記號碼: 7264。

11-13. *Dictyonema uniforme* Mu

11. 正型標本, 原大 ( $\times 1$ ); 本溪豆腐溝下奧陶紀治里統。登記號碼: 7265a。
12. 同上標本的放大 ( $\times 2$ )。
13. 另一標本, 副型標本, 放大 ( $\times 2$ )。遼陽烟台五頂山下奧陶紀治里統。登記號碼: 7266a。





## 圖版 II

### 1-5. *Dictyonema asiaticum* Hsü

1. 比較完整的筆石體,放大 ( $\times 2$ ), 近型標本 (plesiotype); 湖北宜昌分鄉場宜昌統。登記號碼: 7270。
2. 另一筆石體,原大 ( $\times 1$ ), 近型標本; 產地同上。登記號碼: 7271。
3. 同上標本,放大 ( $\times 2$ )。
4. 另一不完整筆石體,近型標本,放大 ( $\times 2$ ); 產地同上。登記號碼: 7272。
5. 筆石枝的一段,放大 ( $\times 5$ ), 示胞管及其口刺,近型標本; 湖北長陽柑子坪下奧陶紀宜昌統。登記號碼: 7273。

### 6. *Dictyonema* sp. C. 正型標本,放大 ( $\times 2$ ); 貴州湄潭岩孔堡中奧陶紀艾家山統。登記號碼: 7277。

### 7-8. *Dictyonema* sp. B.

7. 副型標本 (paratype), 放大 ( $\times 2$ ); 遼寧遼陽五頂山治里統。登記號碼: 7276。
8. 正型標本 (holotype), 放大 ( $\times 2$ ); 遼寧本溪豆腐溝治里統。登記號碼: 7275。

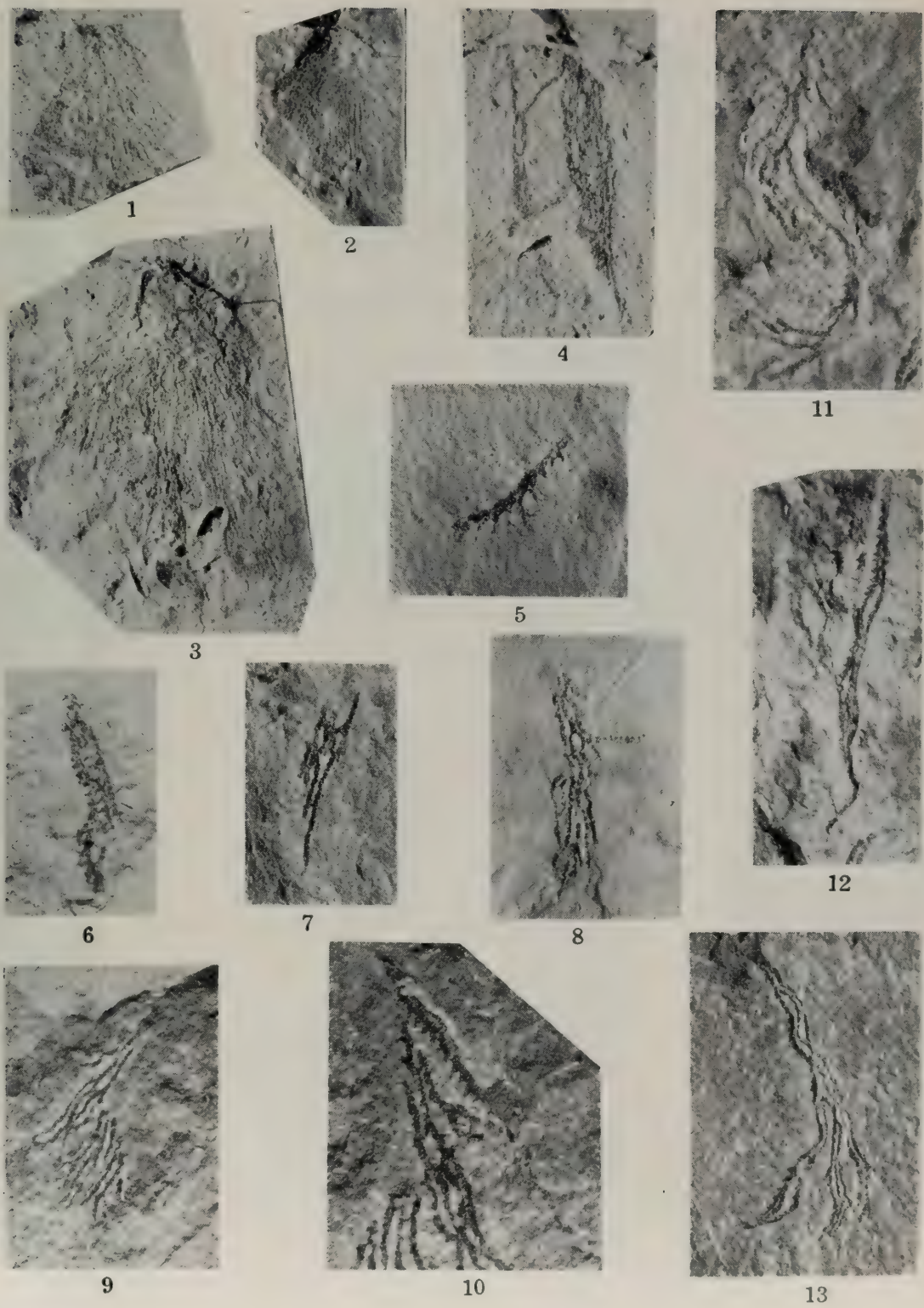
### 9-10. *Dictyonema szechuanense* sp. nov.

9. 不完整的筆石體,正型標本,放大 ( $\times 3$ ); 四川華蓥山中奧陶紀艾家山統。登記號碼: 7274a。
10. 同上標本的反對面,放大 ( $\times 5$ ), 示胞管的形狀。登記號碼: 7274b。

### 11-13. *Dictyonema flexiliramosum* sp. nov.

- 11-12. 副型標本,放大 ( $\times 3$ ); 遼寧本溪田師付治里統。登記號碼: 7268, 7269。
13. 正型標本,放大 ( $\times 3$ ); 遼寧遼陽五頂山治里統。登記號碼: 7267a。





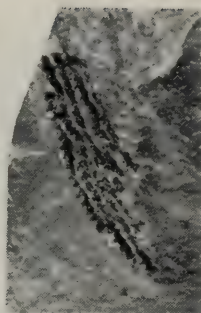
### 圖版 III

1. *Dictyonema* sp. aff. *delicatulum* Lapworth, 近型標本, 放大 ( $\times 3$ ); 西康省天全縣鴛鴦岩下志留紀龍馬溪頁岩。登記號碼 7278。
- 2-4. *Dictyonema* sp. 放大 ( $\times 3$ ), 本溪豆腐溝治里統。登記號碼: 7279—7281。
- 5-7. *Dictyonema* sp. indet. 放大 ( $\times 3$ ), 遼陽五頂山治里統。登記號碼: 7282—7284。
8. *Aspidograptus* sp. 正型標本, 放大 ( $\times 2$ ), 湖北長陽柑子坪宜昌統。登記號碼: 7311。
- 9-12. *Reticulograptus yangi* sp. nov. 共型標本, 放大 ( $\times 2$ ), 本溪田師付治里統。圖 9 筆石體的末部, 其餘 10—12 爲始部。登記號碼: 7285—7288。
- 13-14. *Desmograptus* sp.
  13. 正型標本, 放大 ( $\times 3$ ), 湖北長陽高家嶺宜昌統。登記號碼: 7289a。
  14. 同上標本的反對面, 放大 ( $\times 3$ )。登記號碼: 7289b。
- 15-17. *Airograptus* sp. aff. *furciferus* Ruedemann.
  15. 近型標本, 放大 ( $\times 2$ ), 本溪豆腐溝治里統。登記號碼: 7290a。
  16. 同上標本的反對面, 放大 ( $\times 5$ ), 示胞管的性質。登記號碼: 7290b。
  17. 另一近型標本, 筆石枝的一段放大 ( $\times 2$ )。登記號碼: 7291。

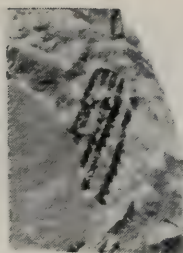




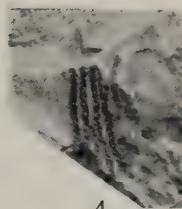
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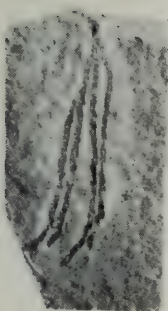
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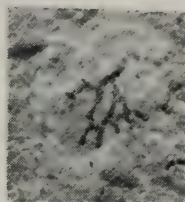
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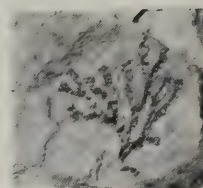
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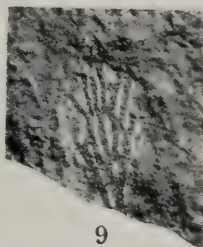
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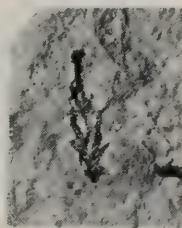
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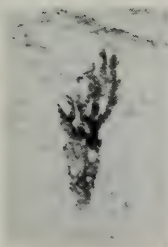
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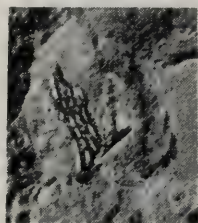
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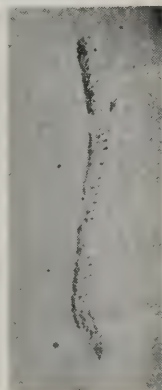
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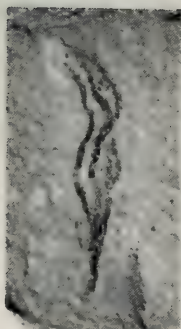
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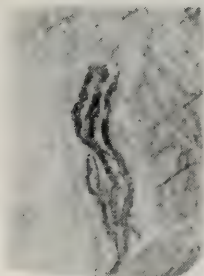
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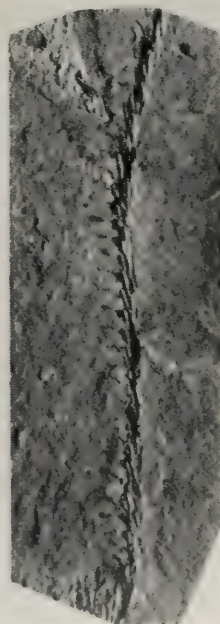
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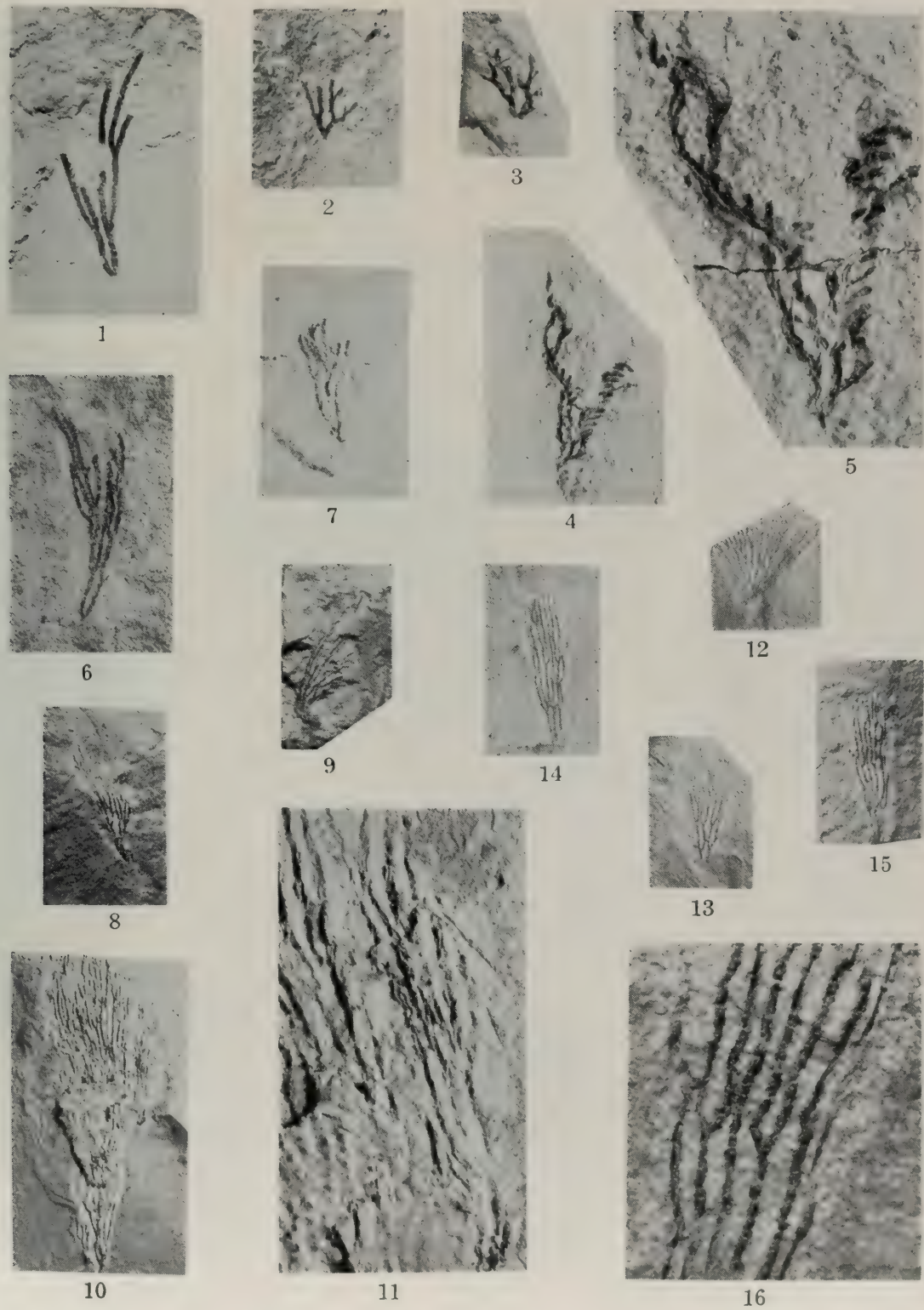


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#### 圖版 IV

- 1-2. *Callograptus staufferi* Ruedemann
1. 近型標本, 放大 ( $\times 2$ ); 山西偏關縣黃河岸, 上寒武紀鳳山統。登記號碼: 7292。
  2. 另一近型標本, 放大 ( $\times 2$ )。登記號碼: 7293。
- 3-5. *Callograptus yangtzensis* sp. nov.
3. 副型標本, 放大 ( $\times 2$ ); 湖北長陽柑子坪宜昌統。登記號碼: 7303。
  4. 正型標本, 放大 ( $\times 2$ ); 產地同上。登記號碼: 7302。
  5. 同上標本, 放大 ( $\times 5$ ); 示胞管的性質。
- 6-7. *Callograptus* sp. aff. *hopkinsoni* Bulman
6. 近型標本, 原大 ( $\times 1$ ); 遼寧本溪駱駝砬子治里統。登記號碼: 7300a。
  7. 另一標本, 原大 ( $\times 1$ ); 產地同上。登記號碼: 7301a。
- 8-11. *Callograptus sinicus* sp. nov.
- 8-10. 共型標本, 原大 ( $\times 1$ ); 示莖及附着盤; 本溪田師付治里統。登記號碼: 7297a, 7298, 7299a。
  11. 圖 10 標本的一部分, 放大 ( $\times 5$ ); 示胞管的性質。
- 12-16. *Callograptus curvithecalis* sp. nov.
- 12-15. 共型標本, 原大 ( $\times 1$ ); 本溪田師付治里統。登記號碼: 7294, 7295, 7296a, 7296b。
  16. 圖 15 標本的一部分, 放大 ( $\times 5$ ); 示胞管的性質, 注意彎曲的副胞管。





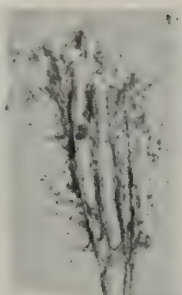
## 圖版 V

- 1-5. *Callograptus? taitzhoensis* Mu
  1. 正型標本, 原大 ( $\times 1$ ); 本溪豆腐溝治里統。登記號碼: 7304a。
  2. 同上標本, 放大 ( $\times 2$ )。
  - 3-4. 副型標本, 放大 ( $\times 2$ ), 產地同上。登記號碼: 7305a, 7306a。
  5. 副型標本, 放大 ( $\times 2$ ), 本溪田師付豆腐溝治里統。登記號碼: 7307a。
- 6-7. *Callograptus? taitzhoensis* var. *minor* var. nov.
  6. 正型標本, 放大 ( $\times 3$ ); 本溪豆腐溝治里統。登記號碼: 7309a。
  7. 同上標本, 放大 ( $\times 10$ ); 示胞管的性質。
8. *Dendrograptus* sp. 正型標本, 放大 ( $\times 2$ ); 遼陽五頂山鳳山統。登記號碼: 7312。
- 9-11. *Dendrograptus suni* sp. nov.
  9. 正型標本, 放大 ( $\times 2$ ); 本溪豆腐溝治里統。登記號碼: 7315a。
  10. 副型標本, 原大 ( $\times 1$ ); 產地同上。登記號碼: 7316a。
  11. 同上標本的反對面, 放大 ( $\times 2$ )。登記號碼: 7316b。
12. *Dendrograptus odontocauloides* Mu 正型標本, 放大 ( $\times 2$ ), 本溪豆腐溝治里統。登記號碼: 7313a。
- 13-15. *Dendrograptus sinensis* Mu
  13. 正型標本, 原大 ( $\times 1$ ); 本溪豆腐溝治里統。登記號碼: 7314a。
  14. 同上標本, 放大 ( $\times 2$ )。
  15. 同上標本的反對面, 放大 ( $\times 2$ )。登記號碼: 7314b。





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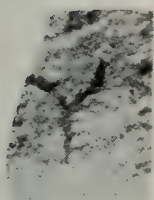
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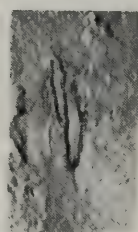
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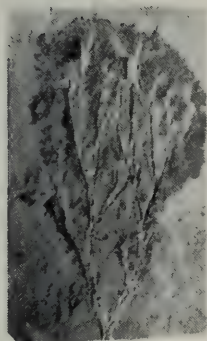
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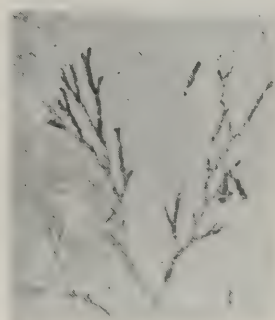
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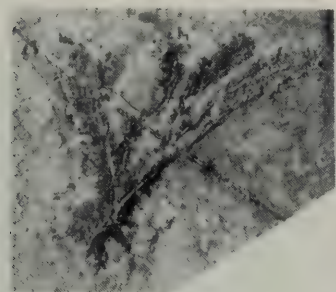


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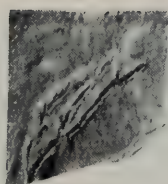
## 圖版 VI

- 1-3. *Dendrograptus y-wangi* sp. nov.  
1. 完整的筆石體, 正型標本, 放大 ( $\times 2$ ); 遼寧本溪豆房溝治里統。登記號碼: 7317a。  
2. 副型標本, 放大 ( $\times 2$ ); 產地同上。登記號碼: 7318a。  
3. 另一副型標本, 放大 ( $\times 5$ ); 示胞管的形狀, 產地同上。登記號碼: 7319a。
- 4-8. *Dendrograptus liaotungensis* sp. nov.  
4-5. 筆石體的始部, 共型標本, 放大 ( $\times 2$ ); 遼寧本溪豆房溝治里統。登記號碼: 7320, 7321。  
6-7. 筆石體的始部, 共型標本, 放大 ( $\times 2$ ); 遼寧遼陽五頂山治里統。登記號碼: 7322, 7323。  
8. 筆石體的末部, 共型標本, 放大 ( $\times 2$ ); 產地同上。登記號碼: 7324。
- 9-14. *Dendrograptus lotolatzensis* sp. nov.  
9. 完整的筆石體, 正型標本, 原大 ( $\times 1$ ); 遼寧本溪駱駝砬子治里統。登記號碼: 7327。  
10. 同上標本, 放大 ( $\times 2$ )。  
11. 另一筆石體, 副型標本, 原大 ( $\times 1$ ); 產地同上。登記號碼: 7328。  
12. 另一副型標本, 放大 ( $\times 2$ ); 產地同上。登記號碼: 7329a。  
13. 同上標本的反對面, 放大 ( $\times 5$ ), 示莖及附着盤的形狀。登記號碼: 7329b。  
14. 另一標本的放大 ( $\times 5$ ), 示胞管的形狀; 產地同上。登記號碼: 7332。
- 15-16. *Dendrograptus flexiramis* sp. nov.  
15. 不完整的筆石體, 放大 ( $\times 3$ ), 共型標本, 示莖及附着盤; 遼寧本溪田師付治里統。登記號碼: 7325。  
16. 另一共型標本, 放大 ( $\times 3$ ), 示胞管的形狀; 產地同上。登記號碼: 7326。

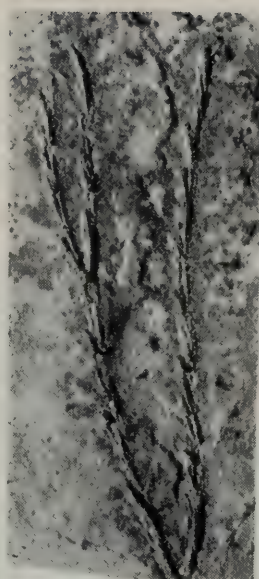




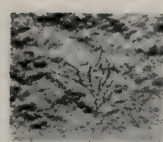
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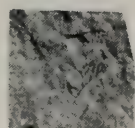
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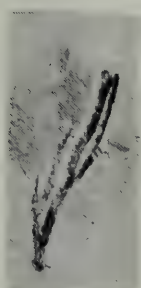
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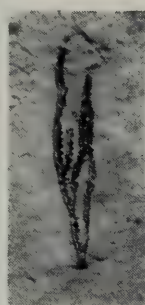
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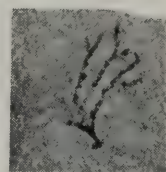
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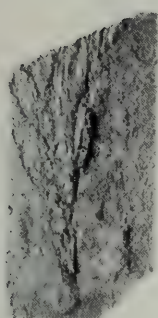
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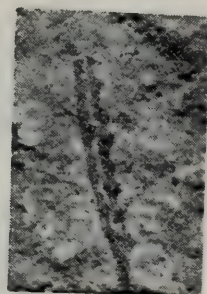
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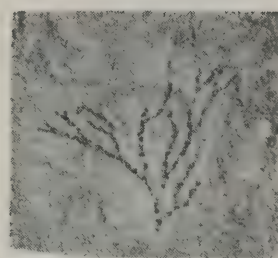
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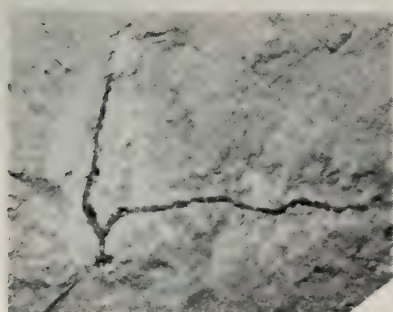
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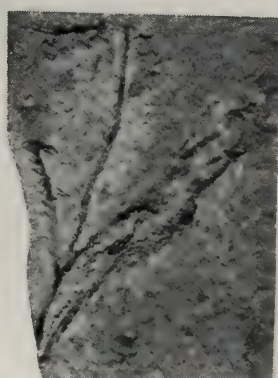
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## 圖版 VII

1-4. *Dendrograptus hsiü* sp. nov.

1. 比較完整的筆石體, 正型標本, 原大 ( $\times 1$ ); 湖北長陽高家嶺宜昌統。登記號碼: 7334。
2. 同上標本, 放大 ( $\times 5$ )。
3. 另一不完整的筆石體, 原大 ( $\times 1$ ); 產地同上。登記號碼: 7335。
4. 同上標本, 放大 ( $\times 3$ )。

5-10. *Dendrograptus yangtzensis* sp. nov.

5. 比較完整的筆石體, 正型標本, 放大 ( $\times 3$ ); 湖北長陽高家嶺宜昌統。登記號碼: 7337。
- 6-7. 副型標本, 筆石體的始部, 放大 ( $\times 3$ ); 產地同上。登記號碼: 7338, 7339。
8. 另一標本, 像筆石體的末部, 放大 ( $\times 3$ ); 產地同上。登記號碼: 7340。
- 9-10. 破碎的標本, 放大 ( $\times 3$ ), 產地同上。登記號碼: 7341, 7342。

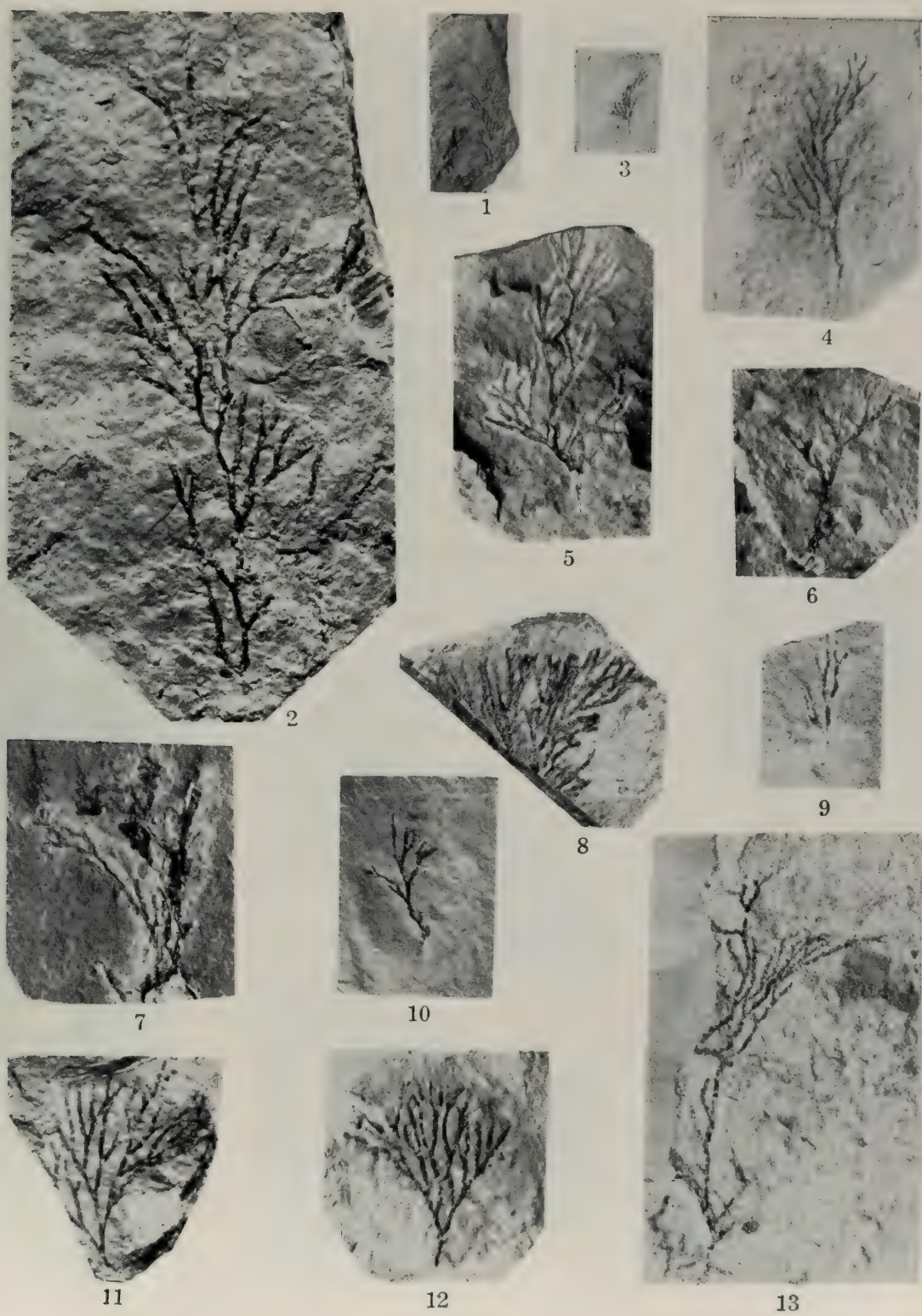
11-12. *Dendrograptus yini* sp. nov.

11. 完整的筆石體, 正型標本, 放大 ( $\times 3$ ); 湖北長陽高家嶺宜昌統。登記號碼: 7343。
12. 另一完整的筆石體, 副型標本, 放大 ( $\times 3$ ); 產地同上。登記號碼: 7344。

13. *Dendrograptus ptilograptoides* Mu

- 完整的筆石體, 正型標本, 放大 ( $\times 2$ ); 遼寧本溪駱駝砬子治里統。登記號碼: 7333a。





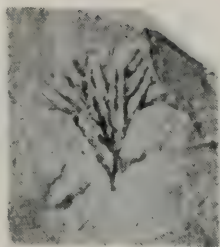
## 圖版 VIII

1. *Dendrograptus yini* var.  $\alpha$   
完整的筆石體, 正型標本, 放大 ( $\times 3$ ); 湖北長陽柑子坪宜昌統。登記號碼: 7345。
- 2-3. *Dendrograptus yini* var.  $\beta$ 
  2. 比較完整的筆石體, 正型標本, 放大 ( $\times 3$ ); 湖北長陽多寶寺宜昌統。登記號碼: 7346。
  3. 另一標本(副型標本), 放大 ( $\times 3$ ); 產地同上。登記號碼: 7347。
- 4-5. *Dendrograptus hupehensis* sp. nov.
  4. 比較完整的筆石體, 正型標本, 放大 ( $\times 3$ ); 湖北長陽柑子坪宜昌統。登記號碼: 7348a。
  5. 同上標本的反對面末部放大 ( $\times 10$ ), 示胞管的性質。登記號碼: 7348b。
- 6-8. *Phlograptus glomeratus* var. *sinicus* var. nov.
  6. 不完整的筆石體, 正型標本, 原大 ( $\times 1$ ); 四川華蓥山中奧陶紀艾家山統。登記號碼: 7349。
  7. 同上標本, 放大 ( $\times 3$ )。
  8. 另一標本(副型標本), 放大 ( $\times 3$ ); 產地同上。登記號碼: 7350a。
9. *Acanthograptus bifurcus* Hsü  
不完整的筆石體, 近型標本, 放大 ( $\times 2$ ); 湖北長陽。登記號碼: 7353。
- 10-13. *Acanthograptus macilentus* Hsü
  - 10-12. 不完整的筆石體, 近型標本, 放大 ( $\times 3$ ); 湖北長陽高家嶺宜昌統。登記號碼: 7354, 7355, 7356。
  13. 另一近型標本, 放大 ( $\times 10$ ), 示胞管的性質; 湖北宜昌分鄉場宜昌統。登記號碼: 7357。
14. *Acanthograptus sinensis* Hsü  
近型標本, 放大 ( $\times 2$ ); 湖北長陽柑子坪宜昌統。登記號碼: 7351a。
- 15-16. *Acanthograptus rigidus* Hsü
  - 近型標本, 放大 ( $\times 3$ ); 湖北長陽高家嶺宜昌統。登記號碼: 7358a, 7359a。
17. *Acanthograptus flexiramiatus* Hsü  
近型標本, 放大 ( $\times 2$ ); 湖北長陽柑子坪宜昌統。登記號碼: 7352a。

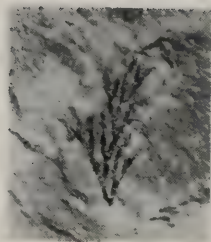




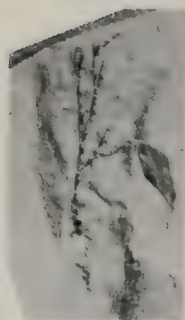
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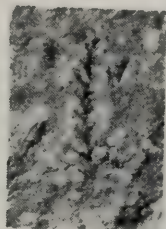
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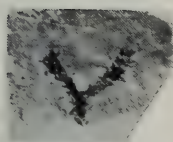
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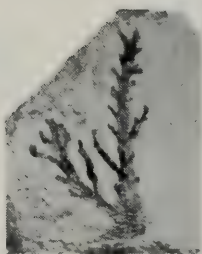
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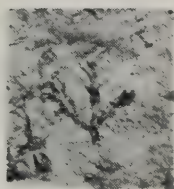
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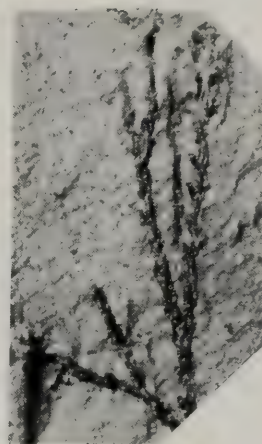
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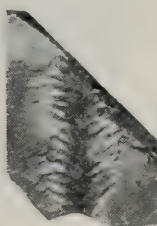
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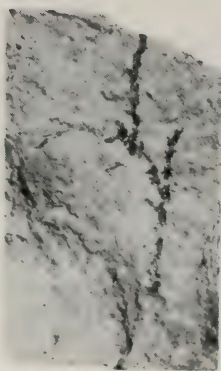
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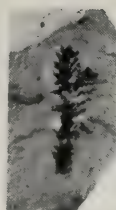
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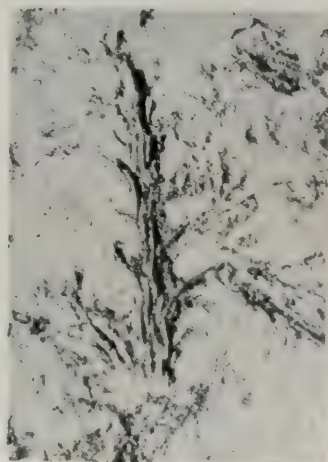
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16



17

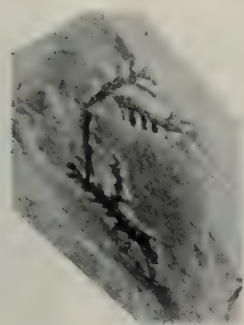


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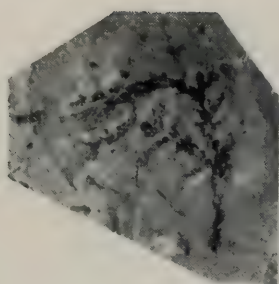
## 圖版 IX

- 1-2. *Acanthograptus flexilis* sp. nov.  
共型標本, 放大 ( $\times 3$ ); 湖北長陽高家嶺及柑子坪的宜昌統。登記號碼: 7360, 7361。
3. *Acanthograptus intermedius* sp. nov.  
正型標本, 放大 ( $\times 3$ ); 湖北長陽高家嶺宜昌統。登記號碼: 7362。
4. *Coremagraptus?* sp.  
正型標本, 放大 ( $\times 3$ ); 湖北長陽柑子坪宜昌統。登記號碼: 7363a。
5. *Inocaulis sinensis* sp. nov.  
正型標本, 放大 ( $\times 3$ ); 遼寧本溪駱駝砬子治里統。登記號碼: 7364。
- 6-7. *Inocaulis?* sp. B.  
6. 正型標本, 原大 ( $\times 1$ ); 遼寧遼陽烟台五頂山治里統。登記號碼: 7367。  
7. 副型標本, 原大 ( $\times 1$ ); 遼寧本溪田師付治里統。登記號碼: 7368。
- 8-9. *Inocaulis?* sp. A.  
8. 副型標本, 原大 ( $\times 1$ ); 遼寧本溪田師付治里統。登記號碼: 7366。  
9. 正型標本, 原大 ( $\times 1$ ); 產地同上, 登記號碼: 7365。
- 10-13. *Bryograptus?* *shengi* sp. nov.  
10. 比較完整的筆石體, 正型標本, 原大 ( $\times 1$ ); 遼寧本溪小市山城子治里統。登記號碼: 7375a。  
11. 同上標本, 放大 ( $\times 3$ )。  
12. 另一標本, 筆石體的始部, 副型標本, 原大 ( $\times 1$ ), 產地同上。登記號碼: 7376a。  
13. 同上標本, 放大 ( $\times 5$ ), 示浮盤及胞管的性質。
- 14-15. *Anisograptus lui* Mu  
14. 不太完整的筆石體, 正型標本, 原大 ( $\times 1$ ); 遼寧烟台五頂山治里統。登記號碼: 7369a。  
15. 零散的筆石枝(副型標本), 放大 ( $\times 5$ ), 示胞管的形狀; 產地同上。登記號碼: 7370。
16. *Anisograptus* cf. *matanensis* var. *tetragraptoides* Bulman  
近型標本, 放大 ( $\times 3$ ); 浙江江山南焦, 印渚埠頁岩。登記號碼: 7371a。
- 17-18. *Bryograptus yentaiensis* sp. nov.  
17. 完整的筆石體, 正型標本, 放大 ( $\times 3$ ); 遼寧烟台五頂山治里統。登記號碼: 7372。  
18. 不完整的筆石體, 副型標本, 放大 ( $\times 3$ ); 注意胎胞管及其尖端的小浮盤, 產地同上。登記號碼: 7373。

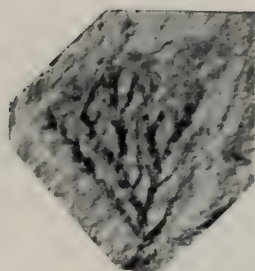




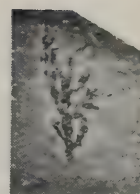
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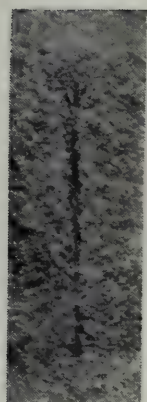
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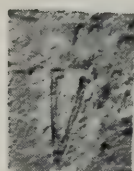
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5



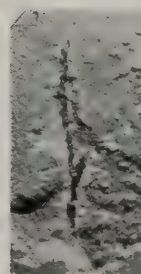
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7



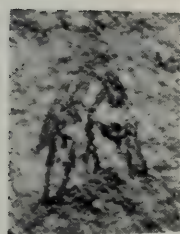
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9



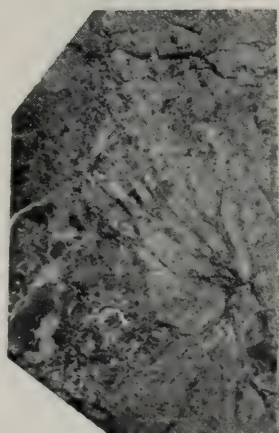
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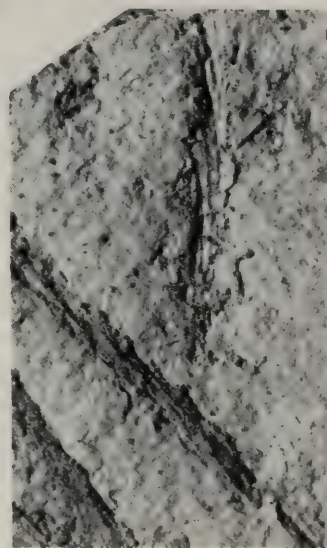
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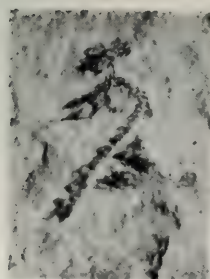
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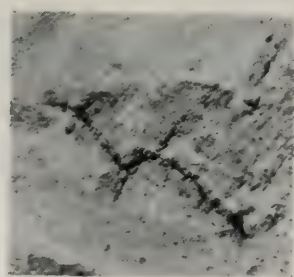
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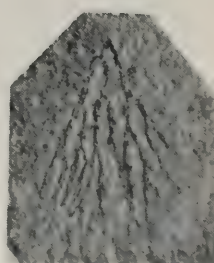
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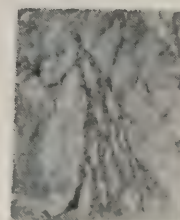
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16



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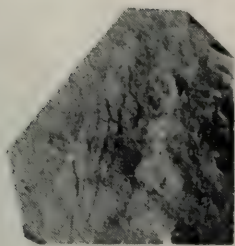
18

## 圖版 X

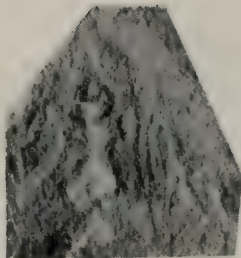
- 1-3. *Bryograptus chekiangensis* sp. nov.
  1. 不完整的筆石體, 正型標本, 原大 ( $\times 1$ ); 浙江江山黃泥崗印渚埠頁岩。登記號碼: 7374a。
  2. 同上標本的反對面。登記號碼: 7374b。
  3. 同上圖的放大 ( $\times 5$ ), 示筆石枝及胞管的性質。
- 4-7. *Adelograptus asiaticus* sp. nov.
  4. 比較完整的筆石體, 正型標本, 放大 ( $\times 3$ ); 浙江江山南焦, 印渚埠頁岩。登記號碼: 7380。
  - 5-6. 兩個幼年標本, 放大 ( $\times 3$ ); 產地同上。登記號碼: 7381, 7382。
  7. 副型標本, 放大 ( $\times 3$ ); 產地同上。登記號碼: 7383。
8. *Adelograptus sinicus* sp. nov.
  - 正型標本, 放大 ( $\times 3$ ); 浙江江山黃泥崗印渚埠頁岩。登記號碼: 7384。
- 9-13. *Clonograptus tenellus* var. *calavei* Elles et Wood
  9. 不甚完整的標本, 筆石體的始部, 近型標本, 原大 ( $\times 1$ ); 浙江江山南焦, 印渚埠頁岩。登記號碼: 7377。
  10. 另一近型標本, 筆石體的一半, 原大 ( $\times 1$ ); 產地同上。登記號碼: 7378a。
  11. 同上標本, 放大 ( $\times 2$ )。
  12. 同上標本的反對面, 原大 ( $\times 1$ )。登記號碼: 7378b。
  13. 筆石枝的一段, 放大 ( $\times 2$ ), 示胞管的形狀。登記號碼: 7379。

(標本保存在中國科學院古生物研究所。劉雪筠攝影。)

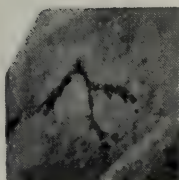




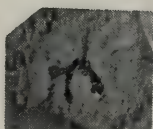
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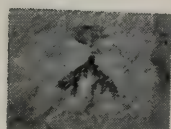
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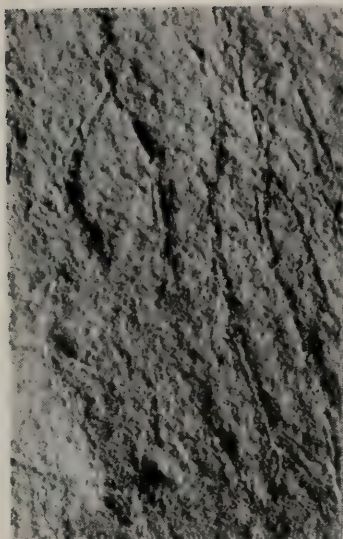
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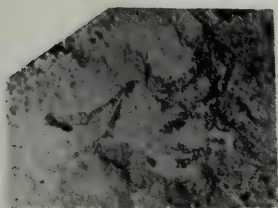
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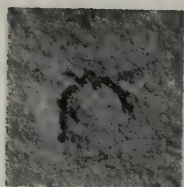
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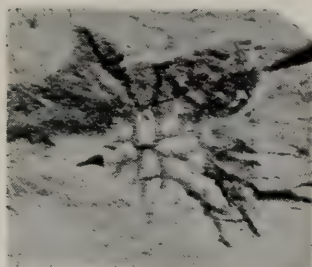
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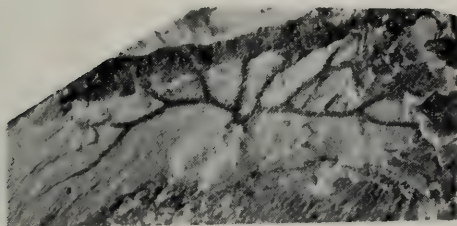
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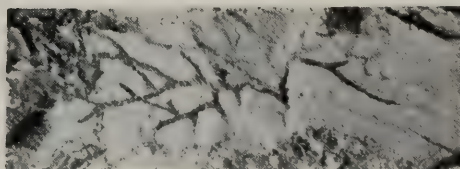
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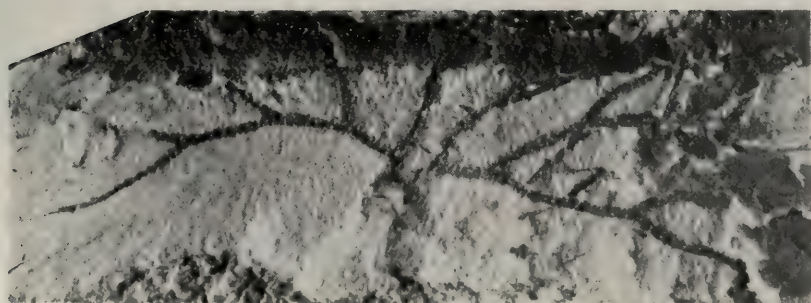
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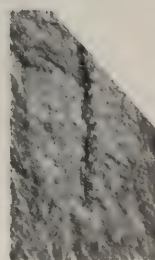
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## THE NEW MATERIALS OF THE DENDROID GRAPTOLITES OF CHINA

By

A. T. Mu

With 14 Text-figures and 10 Plates

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# THE NEW MATERIALS OF THE DENDROID GRAPTOLITES OF CHINA

A. T. MU

*Institute of Palaeontology, Academia Sinica*

(with 10 plates and 14 textfigures)

## INTRODUCTION

The dendroid graptolites of China have been studied for more than two decades. Many important species of the genera *Dictyonema*, *Desmograptus*, *Callograptus*, *Dendrograptus* and *Acanthograptus* have been previously described by Professors Y. C. Sun (1933, 1935), T. H. Yin (1937) and Singwu C. Hsü (1948). All these dendroids are the Lower Ordovician (Tremadocian and Arenigian) forms obtained from Hopei, Hupeh, Kiangsi and Yunnan provinces. During recent years, additional specimens of dendroids ranging from Upper Cambrian to Lower Silurian have been found from different localities in the provinces of Liaoning, Shansi, Inner Mongolia, Sikang, Szechuan, Kueichou and Chekiang. It is this recently acquired material forwarded to the writer for examination by many collectors which forms the subject of the present account. The majority of the specimens were collected from the Yehli formation (Tremadocian) of the Taitzeho valley, Liaoning and from the Ichang formation (Tremadocian) of the Changyang district, W. Hupeh. The graptolite association of each locality may be listed below:

1. Taitzeho valley, Liaoning. Upper Cambrian and Tremadocian dendroids collected by Y. Wang, Y. H. Lu, K. C. Yang, J. C. Sheng and the writer.

*Dictyonema flabelliforme liaotungense* Mu

*D. flexiliramosus* sp. nov.

*D. uniforme* Mu

*D. wutingshanense* sp. nov.

*D. sp. B*

*D. spp. indet.*

*Reticulograptus yangi* sp. nov.

*Callograptus curvithecalis* sp. nov.

*C. sinicus* sp. nov.

*C. sp. aff. C. hopkinsoni* Bulman

*C.?* *taitzehoensis* Mu

*C.?* *taitzehoensis* var. *minor* var. nov.

*Airograptus* sp. aff. *A. furciferus* Ruedemann

*Dendrograptus lotolatzensis* sp. nov.

*D. liaotungensis* sp. nov.

*D. odontocauloides* Mu

*D. ptilograptoides* Mu

*D. sinensis* Mu

*D. suni* sp. nov.

*D. y-wangi* sp. nov.

*D. sp.*

*Anisograptus lui* Mu

*Bryograptus yentaiensis* sp. nov.

*B.?* *shengi* sp. nov.

*Inocaulis sinensis* sp. nov.

*I.?* sp. A.

*I.?* sp. B.

2. Huangho gorge, W. Shansi and Inner Mongolia. Upper Cambrian and Tremadocian dendroid graptolites collected by F. H. Chia and T. L. Kao.

*Dictyonema* sp. A.

*Callograptus staufferi* Ruedemann

*Dendrograptus* sp. indet.

3. Changyang district, W. Hupeh, Lower Ordovician (Upper Tremadocian) dendroids collected by K. C. Yang and the writer.

- Dictyonema asiaticum* Hsü  
*Desmograptus* sp.  
*Callograptus yangtzensis* sp. nov.  
*Aspidograptus* sp.  
*Dendrograptus hsüi* sp. nov.  
*D. hupehensis* sp. nov.  
*D. yangtzensis* sp. nov.  
*D. yini* sp. nov.  
*D. yini* var.  $\alpha$
4. Huayingshan, Szechuan. Middle Ordovician forms collected by Y. H. Lu.  
*Dictyonema szechuanense* sp. nov. *Ptilograptus glomeratus* var. *sinicus* var. nov.
5. Meitan district, N. Kueichou. One Middle Ordovician species collected by S. F. Sheng.  
*Dictyonema* sp. C.
6. Tienchuan district, Sikang province. One Lower Silurian Dendroid graptolite collected by Y. C. Cheng and others.  
*Dictyonema* sp. aff. *D. delicatulum* Lapworth.
7. Kiangshan-Changshan area, W. Chekiang. Tremadocian graptolites collected by Y. H. Lu, Y. T. Hou, J. T. Chang, T. Y. Liu and the writer.  
*Anisograptus* cf. *matanensis* var. *tetragraptoides* Bulman *A. sinicus* sp. nov.  
*Bryograptus chekiangensis* sp. nov. *Clonograptus tenellus* var. *calavei* Elles et Wood.  
*Adelograptus asiaticus* sp. nov.

### Table of Stratigraphical Distribution of the Chinese Dendroid Graptolites

Dendrograptidae	Upp.	L.	Ord.	Mid.	Upp.	Low.
Dictyoneminae	Cam.	Trem.	Aren.	Ord.	Ord.	Sil.
<i>Dictyonema</i>						
<i>D. asiaticum</i> Hsü .....						+
<i>D. flabelliforme liaotungense</i> Mu .....						+
<i>D. flabelliforme orientale</i> Sun .....						+
<i>D. flexiliramosum</i> Mu .....						+
<i>D. szechuanense</i> Mu .....						+
<i>D. uniforme</i> Mu .....						+
<i>D. wutingshanense</i> Mu .....						+
<i>D. sp. aff. delicatulum</i> Lapworth .....						+
<i>D. sp. Yin</i> .....						+
<i>D. sp. A.</i> .....						+
<i>D. sp. B.</i> .....						+
<i>D. sp. C.</i> .....						+
<i>D. sp. indet.</i> .....						+
<i>Reticulograptus</i>						
<i>R. yangi</i> Mu .....						+
<i>Desmograptus</i>						
<i>D. yehliensis</i> Sun .....						+
<i>D. sp. Yin</i> .....						+
<i>D. sp.</i> .....						+



Dendrograptidae	Upp.	L.	Ord.	Mid.	Upp.	Low.
Callograptinae	Cam.	Trem.	Aren.	Ord.	Ord.	Sil.
<i>Airograptus</i>						
<i>A. sp. aff. A. furciferus</i> Ruedemann .....						+
<i>Aspidograptus</i>						
<i>A. sp.</i> .....						+
<i>Callograptus</i>						
<i>C. bulmani</i> Sun .....						+
<i>C. curvithecalis</i> Mu .....						+
<i>C. sp. aff. hopkinsoni</i> Bulman .....						+
<i>C. salteri</i> Hall .....						+
<i>C. sinicus</i> Mu .....						+
<i>C. staufferi</i> Ruedemann .....						+
<i>C. yangtzensis</i> Mu .....						+
<i>C.? taitzehocnsis</i> Mu .....						+
<i>C.? taitzehocnsis minor</i> Mu .....						+
Dendrograptinae						
<i>Dendrograptus</i>						
<i>D. grabaui</i> Sun .....						+
<i>D. hsüi</i> Mu .....						+
<i>D. hupehensis</i> Mu .....						+
<i>D. irregulis</i> Sun .....						+
<i>D. liaotungensis</i> Mu .....						+
<i>D. lotolatzensis</i> Mu .....						+
<i>D. odontocauloides</i> Mu .....						+
<i>D. ptilograptoides</i> Mu .....						+
<i>D. sinensis</i> Mu .....						+
<i>D. suni</i> Mu .....						+
<i>D. yini</i> Mu .....						+
<i>D. yini</i> var. $\alpha$ .....						+
<i>D. yini</i> var. $\beta$ .....						+
<i>D. y-wangi</i> Mu .....						+
<i>D. sp.</i> .....						+
<i>Ptilograptus</i>						
<i>P. glomeratus sinicus</i> Mu .....						+
Acanthograptidae						
<i>Acanthograptus</i>						
<i>A. bifurcus</i> Hsü .....						+
<i>A. erectoramosus</i> Hsü .....						+
<i>A. flexilis</i> Mu .....						+
<i>A. flexiramiatus</i> Hsü .....						+
<i>A. intermedius</i> Mu .....						+
<i>A. kaoi</i> Sun .....						+
<i>A. macilentus</i> Hsü .....						+
<i>A. rigidus</i> Hsü .....						+
<i>A. sinensis</i> Hsü .....						+
<i>A. sinensis fenhsiangensis</i> Hsü .....						+
<i>A. sinensis ituensis</i> Hsü .....						+

	Upp.	L.	Ord.	Mid.	Upp.	Low.
	Cam.	Trem.	Aren.	Ord.	Ord.	Sil.
Dendrograptidae						
<i>Acanthograptidae</i>						
<i>Coremagraptus</i>						
<i>C.?</i> sp. ....						+
Inocaulidae						
<i>Inocaulis</i>						
<i>I. sinensis</i> Mu .....						+
<i>I.?</i> sp. A. ....						+
<i>I.?</i> sp. B. ....						+
Anisograptidae						
<i>Anisograptus</i>						
<i>A. lui</i> Mu .....						+
<i>A. cf. metanensis tetragraptoides</i> Bulman .....						+
<i>Bryograptus</i>						
<i>B. chekiangensis</i> Mu .....						+
<i>B. yentaiensis</i> Mu .....						+
<i>B.?</i> <i>shengi</i> Mu .....						+
<i>Adelograptus</i>						
<i>A. asiaticus</i> Mu .....						+
<i>A. sinicus</i> Mu .....						+
<i>Clonograptus</i>						
<i>C. tenellus calavei</i> E. et W. ....						+

## GENERAL CONSIDERATION ON THE CHINESE DENDROID FAUNAS

From the foregoing lists, it appears clear that the great majority of the Chinese dendroid graptolites are of the oriental species, only a few forms are known from other continents. *Dictyonema fleballiforme* Eichwald and *Callograptus salteri* Hall are of world-wide distribution. *Callograptus staufferi* Ruedemann is formerly known only from the Upper Cambrian of North America, and *Anisograptus matanensis* var. *tetragraptoides* Bulman is a Tremadocian form of the Matane shale of Quebec, Canada. *Clonograptus tenellus* var. *calavei* Elles et Wood is a typical Tremadocian graptolite of Europe, while *Ptilograptus glomeratus* is a Middle Ordovician species of Bohemia.

From the well preserved specimens described in the present account, the character of the proximal part of the rhabdosome and the detail of the thecal structure may be distinctly observed. These features are of some importance to the ecology and the thecal elaboration of the dendroid graptolites. The presence of a distinct sicula and a floating vesicle in the Cambrian form *Dictyonema wutingshanense* sp. nov. indicates that this most primitive *Dictyonema* is probably planktonic in habit. Similarly, all the Tremadocian anisograptids namely, *Anisograptus*, *Bryograptus*, *Adelograptus* and *Clonograptus* are of the planktonic or epiplanktonic mode of existence. It is of interest to note that the Silurian species *Dictyonema* sp. aff. *D. delicatulum* Lapworth is also a planktonic graptolite, as it is derived from a typical black graptolite shale in association with exclusively planktonic graptoloids.

On the other hand, the presence of a thickened stem with a disc of attachment in *Callograptus sinicus* sp. nov. reveals that it is a bottom-living form in the Tremadocian sea. Similarly, root and basal disc are observed in some species of *Dendrograptus*, such as *Dendrograptus lotolatzensis* sp. nov., *Dendrograptus odontocauloides* Mu, etc. They seem to be all the sessile benthonic graptolites.

The thecal structure may be made out from the pyritized specimens. The autothecae can be divided into three types: (1) They are the simple tubes (denticulate in lateral view) in numerous species, (2) they are tubular



and isolated in *Callograptus yangtzensis* sp. nov., and (3) they are spined in *Dictyonema asiaticum* Hsü, *Dictyonema szechuanensis* sp. nov. and *Airograptus* sp. aff. *A. furciferus* Ruedemann, etc. The bithecae can also be divided into three types: (1) They are simple in many forms, (2) they are slightly curved in *Callograptus sinicus* sp. nov., and (3) they are hooked behind the autothecae in *Callograptus curvithecalis* sp. nov. The turning inwards of the bithecal apertures is, as suggested by Bulman, perhaps analogous to the intervention of the thecae in the Graptoloidea. The hooked bithecae seem formerly to be known only in the late Ordovician and Silurian forms of Europe. On the evidence of the present material, it appears that the hooked bithecae are present in a more primitive form, *Callograptus curvithecalis* sp. nov. of Tremadocian, in China. It is evident that the bithecae of Dendroidea have reached to the last stage, ie. *Dictyonema falciferum* type or *Dictyonema inconstans* type of Bulman, early in the Tremadocian time.

Stratigraphically, the dendroid graptolites of China are distributed in the following zones: (1) *Dictyonema wulingshanense* sp. nov., *Dictyonema* sp. A, *Callograptus staufferi* Ruedemann and *Dendrograptus* sp. occur in the *Quadraticephalus* zone of the Fengshan series, Upper Cambrian. (2) The great majority of the Chinese dendroids are derived from the Tremadocian beds. (3) Only two species *Dictyonema* sp. and *Desmograptus* sp. described by Prof. Yin from Yunnan are late Arenigian in age, occurring probably in the *Didymograptus bifidus* zone. (4) It is noteworthy that *Dictyonema szechuanense* sp. nov., *Dictyonema* sp. C. and *Ptilograptus glomeratus* var. *sinicus* var. nov. occur in the Middle Ordovician Neichiashan formation, for the Middle Ordovician dendroids are formerly unknown in China. So far as the present knowledge goes, the Upper Ordovician dendroids are unknown in this country. (5) Only one Lower Silurian species *Dictyonema* sp. aff. *D. delicatulum* has been found from the *Monograptus* (*Demirastrites*) *convolutus* zone of the Lungmachi shale. The fairly abundant forms of the Devonian and Carboniferous dendroid graptolites in Europe and North America have not yet been discovered in China.

From the foregoing account, it appears clear that the great majority of the Chinese dendroid graptolites are Tremadocian in age. A few remarks should be added, in this connection, concerning the comparison of the Tremadocian graptolite faunas of China.

In China, three different districts of the Tremadocian graptolites are recognized. They are: (1) the Kaiping-Taitzeho district of North China, (2) the Yangtze district of Central China, and (3) the Chientangkiang district of South China. In the first district, *Dictyonema* and *Dendrograptus* are the leading forms, and *Anisograptus* and *Bryograptus* are also present in the Taitzeho valley. The second district is characterized by the predominance of *Acanthograptus* in association with many small *Dendrograpti*. Whereas *Adelograptus* and *Clonograptus* are the peculiar forms of the last district where *Anisograptus* and *Bryograptus* are also present, but no *Dictyonema* and *Dendrograptus* are found. The graptolite fauna of the Kaiping-Taitzeho district bears some resemblance to that of North America, whereas the Tremadocian graptolite fauna of the Chientangkiang district is more closely related to that of Europe. The *Acanthograptus* fauna of the Yangtze district is apparently different from the two.

In the Kaiping-Taitzeho district the graptolites occur in shales intercalated within the limestones throughout the Yehli formation. In this formation, three graptolite zones namely (1) the *Dictyonema* zone, (2) the *Callograptus* zone and (3) the *Dichograptus* zone may be recognized in ascending order. In the Yangtze district the Tremadocian graptolites occur also in shales intercalated within the limestones in the upper part of the Ichang formation. Only one graptolite zone, the zone of *Acanthograptus sinensis*, has been established by Prof. Hsü. In the Chientangkiang district, Tremadocian dendroid graptolites were found from the zone of *Clonograptus-Triarthrus* of the Yinchufu shale. All these Chinese Tremadocian graptolites are in association with trilobites, ostracods and brachiopods, etc. According to the presence of *Anisograptus* and *Bryograptus*, the *Clonograptus-Triarthrus* zone of Chientangkiang valley may be correlated with the *Callograptus* zone of the Kaiping-Taitzeho district. It is difficult to correlate the *Acanthograptus* zone of the Yangtze gorge with the graptolite zones of the other districts. On account of the stratigraphical position and the

associated fossils, the *Acanthograptus* zone may be roughly correlated with the *Dichograptus* zone of the Kaiping basin. It is higher than the *Clonograptus-Triarthrus* zone of the Chientangkiang valley as shown in the following table:

Kaiping-Taitzeho	Yangtze	Chientangkiang
<i>Dichograptus</i>	<i>Acanthograptus</i>	<i>Asaphopsis-Birmanites</i>
<i>Callograptus</i>	<i>Asaphopsis</i>	<i>Clonograptus-Triarthrus</i>
<i>Dictyonema</i>	<i>Dactylocephalus</i>	<i>Hysterolenus</i>

## DESCRIPTION OF SPECIES

### ORDER DENDROIDEA NICHOLSON, 1872

#### Family Dendrograptidae Roemer (in Frech), 1897

#### Subfamily Dictyoneminae Mu, 1953

#### Genus *Dictyonema* Hall, 1851

#### CAMBRIAN SPECIES

#### *Dictyonema wutingshanense* sp. nov.

(Pl. I, figs. 1-4)

This species is represented by several specimens including a rather complete rhabdosome.

The rhabdosome is very small, measuring 11.5 mm in the axial length and 7 mm in the greatest width. The length/breadth ratio is thus 1.6:1. The sicula is rather long, about 1.8 mm in length. The primary stipes diverge from the sicula at an angle of ca. 45°. All the stipes are very thin, thread-like, only 0.2 mm wide in the dorsal view and 0.4 mm in the lateral view, branching at long intervals and forming 24 terminal stipes (12 terminal stipes are visible when compressed). They are widely separated by interspaces 4.5 times as great as their width, numbering 5-6 in 5 mm transversally. The dissepiments are infrequent, very fine, straight and perpendicular to the stipes. They are irregularly distributed, commonly 2-3 mm apart.

The thecae are obscure in the dorsal view of the stipes, whereas in the laterally preserved stipes the autothecae are denticulate, numbering 8-6 in a length of 5 mm of the stipes. They are very small, about 1 mm in length. The apertural margin is even and the ventral margin is concave, forming thus small apertural denticles. The overlap is less than 1/3 the thecal length. The bithecae and stolothecae are hardly observed.

The foregoing description is mainly based on the holotype (Pl. I, figs. 1-2). In a young form regarded as one of the paratypes (Pl. I, fig. 3) the sicula is a long and slender cone with a small floating vesicle or disc of attachment at its apex. From the apical portion of the sicula originates one primary stipe pendently. The presence of a distinct sicula and a floating vesicle indicates that this primitive graptolite is most probably planktonic in the mode of existence.

Remarks: In the shape of the rhabdosome and in the infrequent dissepiments this species resembles *Dictyonema flabelliforme* var. *bryograptoides* Bulman from the *Dictyonema* shale of the Oslo region, Norway, but differs from the latter form in the much smaller rhabdosome and in the mode of branching of the stipes. Furthermore, it occurs at a much lower stratigraphical horizon than *D. flabelliforme* var. *bryograptoides*. The very small siculate rhabdosome and the very thin stipes serve to distinguish this new species from all other known species of the genus *Dictyonema*.

Horizon and Locality: This species occurs in the *Quadraticephalus* zone of the Upper Cambrian Fengshan Series at Wutingshan, Yentai, Liaoyang district of Liaoning in association with *Dendrograptus* sp.

Cat. No. 7258a-b (holotype), 7259-7261 (paratypes).



***Dictyonema* sp. A.**

(Pl. I, fig. 5)

This species is known from a single specimen and its counterpart comprising only 4 stipes. The complete form of the rhabdosome is unknown. The stipes are gently flexuous and subparallel. They are about 0.7 mm in width and separated by interspaces from  $1\frac{1}{2}$  — 2 times as great. The dissepiments are thinner than the stipes, irregularly distributed about 2-3 mm apart. The thecae are obscure due to the poor preservation.

Horizon and Locality: This species occurs in the Upper Cambrian Fengshan Series, probably the *Quadraticiphalus* zone, in the Huangho gorge of the Tsingshuiho district, Inner Mongolia.

Cat. No. 7262a-b (holotype).

**ORDOVICIAN SPECIES*****Dictyonema flabelliforme* var. *liaotungense* Mu**

(Pl. I, figs. 6-10; textfig. 4)

1953 *Dictyonema flabelliforme* var. *liaotungense*, Mu, Acta Palaeontologica Sinica, Vol. I, No. 1, pp. 29; 34; Pl. I, fig. 1.

The rhabdosome is infundibulate in form with the sicular end broken. The axial length of the rhabdosome is 44 mm, and the greatest width is about 30 mm. The length/breadth ratio is 1.5:1. The stipes regularly dichotomize at intervals of 3 mm, 10 mm, 15 mm, etc. distally, forming thus some branching zones. All the stipes are very slightly undulated to nearly straight and parallel to each other. The width of the stipes is uniformly 0.4 mm. They are closely set, about 14 in a space of 10 mm transversally and separated by interspaces approximately equal to or less than the breadth of the stipes. The dissepiments are slightly thinner than the stipes, usually transverse and occasionally oblique. They are infrequent, numbering 2-3 in a length of 10 mm and forming elongate meshes. In the proximal portion of the rhabdosome the anastomosis may be occasionally seen.

The thecae originate on the inner side of the rhabdosome. The outer or dorsal side of the stipes shows a distinctly wrinkled appearance. Both the autothecae and the bithecae are the simple tubes. The bithecae are smaller than the autothecae. The stolothecae are distinctly wrinkled in appearance. In the laterally preserved stipes, the autothecae are denticulate, numbering 15-14 in a length of 10 mm. As the proximal part of the rhabdosome is broken, the character of the sicula is unknown.

Remarks: This form closely resembles *Dictyonema flabelliforme* Eichwald (sensu lato) in the essential characters. It may be regarded as a variety of that species or a distinct species belonging to the group of *Dictyonema flabelliforme* (s.s.). In the manner of branching of the stipes and in the character of the thecae our form stands nearest to *Dictyonema flabelliforme graptolithinum* Kjerulf (= *Dictyonema flabelliforme forma typica* Brögger according to A. M. Obut, 1953), but differs from the latter in the wrinkled stipes and in the shape of meshes. It bears some resemblance to *Dictyonema flabelliforme* Eichwald in the branching zones of stipes. But in the later form the meshes are six-sided to egg-shaped and the stipes are wavy in appearance as pointed out more recently by Obut. In the presence of a few anastomoses this form bears some likeness to *Dictyonema flabelliforme desmograptoides* Hahn, but differs therefrom in the other characters. For the comparison of this form with the other varieties of the species *Dictyonema flabelliforme* (s.l.) the reader is referred to the table 3 given in page 29 of the writer's previous paper (Mu, 1953).

Horizon and Locality: This form is the zone fossil of the *Dictyonema flabelliforme liaotungense* zone of the Yehli formation (Tremadocian) at Lotolatze, Penchi district of Liaoning.

Cat. No. 7263a-b (holotype), 7264 (paratype).

***Dictyonema uniforme* Mu**

(Pl. I, figs. 11-13)

1953, *Dictyonema uniforme*, Mu, Acta Palaeontologica Sinica, Vol. I, No. 1, Pl. I, Fig. 9.

The rhabdosome is elongate with an axial length of 28 mm and a maximum width of 9.5 mm, forming a length/breadth ratio 3:1. The stipes dichotomously branch at intervals of 5 mm in the proximal portion of the rhabdosome and at 8-12 mm in the distal, forming some zones of branching. All the stipes are parallel and gently flexuous with uniform width of about 0.3 mm. They are closely arranged, numbering 8 in a space of 5 mm transversally, 16-17 terminal stipes may be seen in the compressed specimen. The interspaces between the stipes are equal to or slightly greater than the width of the stipes.

The dissepiments are very fine, straight and at right angles to the stipes. They are infrequent and irregular in distribution.

The characters of the thecae are difficultly observed, because all the stipes are preserved in the dorsal view. Along the stipes only traces of the thin and slightly curved tubes are visible. They are probably the autothecae, numbering about 16 in a length of 10 mm of the stipes.

Remarks: In the elongate form of the rhabdosome and in the parallel stipes this species strongly resembles *Dictyonema flabelliforme* var. *sociale* (Salter), but differs therefrom in the character of the meshes. At first glance, this species bears some resemblance to *Callograptus salteri* Hall in the general aspect of the rhabdosome, but differs from the latter species in the greater number of dissepiments. Morphologically, it is an intermediate form between *Dictyonema flabelliforme* (Eichwald) and *Callograptus salteri* Hall.

Horizon and Locality: This species occurs in the *Callograptus? taitzehoensis* zone of the Yehli formation at Tounfengkou, Penchi district, and at Wutingshan, Yentai district, Liaoning in association with *Airograptus* sp. aff. *furciferus*, *Callograptus? taitzehoensis*, *Dendrograptus odontocauloides*, *D. sinensis*, *D. suni*, *D. y-wangi*, etc.

Cat. No. 7265a-b (holotype), 7266a-b (paratype).

***Dictyonema flexiliramosum* sp. nov.**

(Pl. II, figs. 11-13)

Since no complete specimen is obtained, the entire form of the rhabdosome is unknown. In the specimen regarded as the holotype (Pl. II, fig. 13) 8 stipes are preserved. The stipes appear to be very thin (0.2 mm in width) in the dorsal view and more broad (about 0.4 mm across the thecal aperture) in the side view. They are strongly flexuous just as those in *Desmograptus*, but no anastomosis is seen. The stipes are crowded together in the proximal part of the rhabdosome, but are separated in the distal. The dissepiments are infrequent, usually short and thin.

The autothecae are relatively large and acutely denticulate in the side view. The apertural margin of the autothecae is broad and somewhat concave, numbering 20-18 in a length of 10 mm of the stipes. The bithecae are indistinct.

Remarks: In regard to the close arrangement of the thin and flexuous stipes, this species stands nearest to *Dictyonema bulmani* Ruedemann of the Green Point Group (Tremadocian) and *Dictyonema simile* Ruedemann of the St. Paul's group (Lower Ordovician) of New Foundland, North America, but differs from these American species in the close arrangement of the thecae. The stipes in the two American species are gently flexuous in the general outline and sharply zigzagging in detail, whereas the stipes in our species are distinctly flexuous in the general outline. From the other known *Dictyonemas* which have flexuous stipes namely *Dictyonema flabelliforme desmograptoides* Hahn (Tremadocian) and *Dictyonema desmoides* Gurley (Silurian) of North America and *Dictyonema geniculatum* Bulman



(Valentian of Lower Silurian) of Europe, our new species may be distinguished by the absence of the anastomosis and by the number of the thecae in the length of a given unit.

Horizon and Locality: This new species occurs in the *Callograptus? Taitzeensis* zone of the Yehli formation (Tramadocian) at Wutingshan, Yentai and at Tienshihfu, Penchi, Liaoning in association with *Reticulograptus yangi*, *Callograptus curvithecalis*, *C. sinicus* and *C.? taitzeensis* etc.

Cat. No. 7267a-b (holotype), 7268, 7269 (paratypes).

### ***Dictyonema asiaticum* Hsü**

(Pl. II, figs. 1-5)

1948. *Dictyonema asiatica*, Hsü, Contr. Inst. Geol., VIII, pp. 11-12, Pl. I, figs. 1, 2a-b, 3, 4.

Several specimens are referred to this species. The rhabdosome is broadly conical, about 1:1 in the length/breadth ratio. The stipes are slender, subparallel, 0.2-0.3 mm in width, gently undulating and irregularly dichotomizing. There are 15-17 stipes in a space of 10 mm. The dissepiments are very thin, originating from the apertures of the bithecae.

Another specimen of laterally preserved stipe (Pl. II, fig. 5) may also be identical with this species. The autothecae are the long tubes, overlapping for 3/5 their length and numbering 8 in a length of 5 mm. Each aperture of the autothecae is furnished with a long, flexuous and forked spine. The bithecae are small.

For the further information of this species the reader is referred to Prof. Hsü's work (1948).

Remarks: With regard to the character of the spined thecae this species closely resembles *Dictyonema canadense* Lapworth of the Matane shale (Tremadocian) of Quebec, Canada, but differs from the Canadian species in the character of the stipes. These two spined *Dictyonemas* together with *Dictyonema cervicorne* Holm, *D. tuberosum* Wiman etc, may be regarded as belonging to a distinct group of the genus *Dictyonema*.

Horizon and Locality: This species occurs in the *Acanthograptus sinensis* zone of the Ichang formation at Patzelao, Itu; Fenhshiang, Ichang and Kantzeping, Changyang, W. Hupeh in association with *Acanthograptus sinensis* Hsü, *A. bifurcus* Hsü, *A. flexiramiatus* Hsü, *Callograptus yangtzensis* sp. nov. etc.

Cat. No. 7270-7273 (Plesiotypes).

### ***Dictyonema szechuanense* sp. nov.**

(Pl. II, figs. 9-10)

This species is known from a single specimen and its counterpart, comprising only the distal portion of the rhabdosome. The rhabdosome is very small, probably conical. The incomplete specimen is 13 mm in length and 9 mm in breadth.

The stipes are very slender, thread-like, numbering 11 in a space of 5 mm transversally. The interspace between the stipes is equal to or slightly wider than the width of the stipes. The stipes are somewhat flexuous in the distal portion. They branch irregularly, usually at intervals of 4 mm.

The thecae are invisible in the dorsal view of the stipes. While in the side view of the stipes the autothecae are denticulate and furnished with a fine apertural spine. They are closely arranged, about 11-10 in a length of 5 mm. The bithecae are not recognized.

The dissepiments are irregular, usually oblique in position, numbering 5-6 in a space of 5 mm. They are fine, but usually thickened at one end.

Remarks: In the shape of the small rhabdosome and in the thin stipes this new species bears a striking resemblance to *Dictyonema yeltyschevae* Obut from the Middle Ordovician of North-west Russian platform but differs from the Russian species in the characters of the thecae and dissepiments. In the thickness and arrangement of the stipes this species closely resembles the North American Ordovician species *Dictyonema densum* Ruedemann. But the stipes

of the latter species are straight and rigid, branching regularly at intervals of 2.5 mm. From the other spined *Dictyonemas* the present form can be easily distinguished by the small size of the rhabdosome.

Horizon and Locality: This species occurs in the Middle Ordovician Neichiashan formation at Huayinshan, Szechuan in association with *Ptilograptus glomeratus* var. *sinicus* var. nov.

Cat. No. 7274a-b (holotype).

### ***Dictyonema* sp. B.**

(Pl. II, figs. 7-8)

Some fragmentary specimens referred to this species are usually composed of 7-8 stipes. The entire form of the rhabdosome is unknown. The stipes are subparallel and flexuous, branching at intervals of 5-7 mm. They are separated by interspaces equal to or twice as their width, and connected by short dissepiments which are irregular both in position and in distribution.

The autothecae are short, closely arranged, about 10-9 in a length of 5 mm of the stipes. The bithecae are indistinct.

Remarks: In the flexuous appearance of the stipes this species recalls *Dictyonema simile* Ruedemann of North America, but the stipes of our form is not so zigzag as those in the American species. It bears also some resemblance to *Dictyonema flexiramosum* sp. nov. in regard to the character of the flexuous stipes, but the width of the stipes and the character of the thecae in the present form are all different from these in the latter species. At first glance, this form resembles *Dictyonema asiaticum* Hsü, but differs therefrom strikingly in the absence of the thecal spines. This form seems to be a new species, but is too fragmentary to warrant a new specific name.

Horizon and Locality: The present species occurs in the *Callograptus? taitzeensis* zone of the Yehli formation at Toufangkou, Penchi district and at Wutingshan, Liaoyang district, Liaoning.

Cat. No. 7275 (holotype), 7276 (paratype).

### ***Dictyonema* sp. C.**

(Pl. II, fig. 6)

The shape of the rhabdosome is unknown. The fragmentary specimen is composed of several stipes crowded together. It measures 17 mm long and 4 mm wide. The stipes are parallel and nearly in contact. They are about 0.7 mm in breadth exclusive of the thecal spines. The autothecae are triangular in the side view and furnished with fine apertural spines which attach to the back of the preceding stipe. The free part of the thecae occupies more than  $\frac{1}{2}$  the width of the stipes. The autothecae number 14 in a length of 10 mm. The character of the bithecae are obscure. The dissepiments are frequent in the proximal portion of the rhabdosome and infrequent in the distal.

Remarks: This species recalls a species of *Airograptus* in the spined and strongly projecting thecae, but differs therefrom in the greater number of the dissepiments and more fine thecal spines. By the more projecting thecae this species may be distinguished from the other species of *Dictyonema*. This form is apparently new to science, but it is not warrantable to propose a new specific name, until more complete materials are available.

Horizon and Locality: Neichiashan formation (Middle Ordovician), Yenkungpu, Meitan district, N. Kueichou. Cat. No. 7277 (holotype).

## **SILURIAN SPECIES**

### ***Dictyonema* sp. aff. *D. delicatulum* Lapworth**

(Pl. III, fig. 1)

Cf. 1881. *Dictyonema delicatulum*, Lapworth, Quart. Journ. Geol. Soc., Vol. 37, P. 172, Pl. 7, figs. 2a-b.

Cf. 1926. *Dictyonema delicatulum*, Bulman, Palaeontographical Society, Vol. 80, p. 51, Pl. 6, figs. 7-11.

Only one specimen is referred to this species. It measures 13 mm in length and 3 mm in width, consisting



of 6 stipes. All the stipes are parallel and very thin with a width of uniformly 0.25 mm. The branching of stipes is infrequent. The stipes are straight in the general outline, but zigzag in detail due probably to the alternating origin of the thecae from the stolothecae. They are separated by interspace about two times as wide as their breadth.

The thecae are obscure and their number is not clearly recognizable. On account of the geniculations of the stipes there are probably 20 thecae in a length of 10 mm. The dissepiments are fine, irregular, both oblique and transverse in position, numbering 5-6 in a space of 5 mm.

Remarks: In the characters of the stipes and dissepiments, the present form recalls *Dictyonema delicatulum* Lapworth of the British Silurian. They are probably identical, even though our specimen is fragmentary.

Horizon and Locality: This is the only one Silurian species of Dendroidea in China. It occurs in the *Monograptus* (*Demirastrites*) *convolutus* zone of the Lungmachi shale, Tienchuan, Sikang province in association with several species of *Monograptus* (s.l.).

Cat. No. 7278 (plesiotype).

### Genus *Reticulograptus* Wiman, 1901

#### *Reticulograptus yangi* sp. nov.

(Pl. III, figs. 9-12)

This new species is represented by several incomplete specimens. Some of them are the proximal part of the rhabdosome and some are the distal. The rhabdosome is probably conical with a rounded base. From the proximal end of the rhabdosome originate some stipes crowded together, forming an elongate cone. The stipes in the proximal portion of the rhabdosome are robust, about 0.8 mm in width, united by thick dissepiments. Whereas in the distal part of the rhabdosome they are thinner, about 0.5 mm in width, connected by anastomoses or by oblique dissepiments, forming thus the rhombic meshes. They are 6-7 stipes in a space of 5 mm transversally. The stipes are striated in the dorsal view, indicating probably the complexity of the thecae. The detailed character of the thecae is unknown.

Remarks: With regard to the shape of the meshes, this new species closely resembles *Reticulograptus polymorphus* (Gurley) from the North American Silurian, but the rhabdosome of our form is more elongate and the stipes are more robust. The American species occurs at a much higher stratigraphical horizon (Silurian) than ours (Tremadocian).

Horizon and Locality: This species occurs in the lower part of the *Callograptus? taitzeoensis* zone of the Yehli formation, Tienshihfu, Liaoning in association with *Callograptus curvithecalis* sp. nov. and *C. sinicus* sp. nov. etc.

Cat. No. 7285-7288 (syntypes).

### Genus *Desmograptus* Hopkinson, 1875

#### *Desmograptus* sp.

(Pl. III, figs. 13-14)

The rhabdosome is broom-shaped, very small, only 10 mm in length and 2 mm in breadth. It begins with a rather long stem. From the distal end of the stem originate some flexuous stipes. The stipes are thin, ca. 0.3 mm in width, branching at irregular intervals. They are connected by both anastomoses and dissepiments and are separated by interspace equal to the width of the stipes. There are 4-5 stipes in a space of 2 mm transversally. The thecae was obscure.

Remarks: In the shape and size of the rhabdosome the present form recalls *Desmograptus yehliensis* Sun from the Yehli formation of the Kaiping basin, Hopei, but the stipes of the present form is not so strongly flexuous as those in that species.

Horizon and Locality: This species occurs in the zone of *Acanthograptus sinensis* of the Ichang formation (Tremadocian), Kaochialing, Changyang, W. Hupeh.

Cat. No. 7289 (holotype).

### Subfamily Callograptinae Mu, 1953

### Genus *Airograptus* Ruedemann, 1916, emend.

Revised diagnosis: Rhabdosome attached with a short stem, probably conical in form. Stipes branching dichotomously, frequent in proximal portion and infrequent in distal. Branches parallel or subparallel. Dissepiments very rare or absent. Autothecae denticulate, with furcate or peltate apertural processes which may attach to the neighbouring branches.

Genotype: *Dictyonema furciferum* Ruedemann, 1904.

### *Airograptus* sp. aff. *A. furciferus* (Ruedemann)

(Pl. III, figs. 15-17; textfig. 6)

Cf. 1904. *Dictyonema furciferum*, Ruedemann, N.Y. State Mus., Mem. 7, pp. 606-607, Pl. III, fig. 11.

Cf. 1912. *Callograptus grabaui*, Hahn, N.Y. Acad. Sci. Ann., Vol. 22, pp. 142-144, textfig. 1, pl. 20.

Cf. 1916. *Airograptus* (*Dictyonema*) *furciferus*, Ruedemann, N.Y. State Mus., Bull. 189, pp. 17-21, textfigs. 7-8.

Cf. 1947. *Airograptus furciferus*, Ruedemann, Geol. Soc. Amer., Mem. 19, pp. 195-196, Pl. IV, figs. 1-2.

1953. *Airograptus* sp. aff. *A. furciferus*, Mu, Acta Palaeontologica Sinica, Vol. 1, No. 1, p. 29, pl. I, fig. 2.

Two fragmentary specimens are referred to this species. One of them is composed of two bifurcated stipes, and the other is only a simple branch. In the proximal portion of the first specimen (Pl. III, figs. 15, 16) the stipe branches dichotomously at a very small angle. The branches are parallel, bifurcating again at intervals of 15 mm. They are straight, 0.7 mm in width exclusive of the thecal processes. The autothecae are denticulate and steeply inclined to the trend of the branches. Each of them is furnished with a stout peltate apertural spine which is about 0.7 mm in length and has a forked or truncated termination. The autothecae number 17 in a length of 10 mm., overlapping for 2/3 their length or more. The bithecae are also simple tubes but smaller in size.

Remarks: This form closely resembles *Airograptus furciferus* Ruedemann of North America in the peculiar character of the thecal processes. It differs from the American specimen only in the greater width of the stipes. As stated elsewhere, the writer (Mu, 1953, pp. 29, 34) is of the opinion that the genus *Airograptus* is more closely related to *Callograptus* than to *Dictyonema*. The parallel or subparallel stipes and the infrequent dissepiments in this genus are all similar to those in *Callograptus*. It differs from the latter genus only in the presence of the peculiar thecal processes. Ruedemann considers the European species *Dictyonema cervicorne* Holm, *D. tuberosum*, *D. peltalum* and *D. cavernosum* Wiman to be the members of the genus *Airograptus* (Ruedemann, 1947, p. 195). It seems to the writer that these spined species represent a distinct group of *Dictyonema* as mentioned above, because the dissepiments are more frequent in these forms.

Horizon and Locality: The present form occurs in the *Callograptus? taitzehoensis* zone of the Yehli formation (Tremadocian), Toufangkou, Penchi, Liaoning in association with *Dictyonema uniforme*, *Callograptus? taitzehoensis*, *Dendrograptus odontocauloides*, etc.

Cat. No. 7290a-b, 7291 (plesiotypes).



**Genus *Callograptus* Hall, 1865****CAMBRIAN SPECIES*****Callograptus staufferi* Ruedemann**

(Pl. IV, figs. 1-2)

1933. *Callograptus staufferi*, Ruedemann, Bull. Mus. Milwaukee, Vol. 12, No. 3, pp. 319-20, Pl. 50, figs. 1-7; Pl. 55, figs. 1, 2, 5.

1947. *Callograptus staufferi*, Ruedemann, Geol. Soc. Amer. Mem. 19, p. 204, Pl. 16, figs. 7-15.

Two specimens are referred to this species. In one of them (Pl. IV, fig. 1) the branches are straight or gently flexuous, parallel or subparallel to each other. They branch at an interval of 4 mm, or more, forming an acute angle. The width of the branches is uniformly 0.5 mm. There are about 5 branches in a space of 5 mm transversally. The dissepiments are very infrequent and extremely thin. They are usually broken off, only nodes may be seen on the lateral sides of the branches.

The thecae (probably the autothecae) are denticulate in the lateral view with slightly concave ventral margins, overlapping for 1/3 the thecal length or more and numbering 14 in a length of 10 mm of the branches.

The other specimen (Pl. IV, fig. 2) represents a young form, closely resembling the American specimen figured by Ruedemann (Ruedemann, 1933, Pl. 50, fig. 4). The branches are rather slender, branching at an interval of 2 mm.

Remarks: The present form is identical with Ruedemann's species from the North American Cambrian in all the essential characters. The fragmentary specimens of this species bear some resemblance to the Ordovician species *Callograptus salteri* Hall and *C. hopkinsoni* Bulman. But the branches in *Callograptus salteri* are much slender and usually undulating, and those in *Callograptus hopkinsoni* are more robust. When the complete specimens are obtained, they are easily distinguishable.

Horizon and Locality: This species occurs in the *Quadricephalus* zone of the Upper Cambrian Fengshan Series, Huangho gorge, Piankuan, Shensi.

Cat. No. 7292, 7293 (Plesiotype).

**ORDOVICIAN SPECIES*****Callograptus curvithecalis* sp. nov.**

(Pl. IV, figs. 12-16; textfig. 7)

1953. *Callograptus* sp. aff. *C. salteri*, Mu, Acta, Palaeontologica Sinica, Vol. 1, No. 1, Pl. 1, fig. 8.

This new species is represented by some well preserved specimens. The rhabdosome is conical, generally 20-30 mm high and 15-20 mm wide. The stipes are parallel or subparallel to each other with a gentle curvature. They are closely arranged, numbering 7-8 in a space of 5 mm transversally. All the stipes are uniform in width, ca. 0.3 mm and separated by the interspace equal to or twice more than their width. They are connected by infrequent dissepiments which are short and at right angles to the stipes. In the proximal portion of the rhabdosome the stipes branch frequently at intervals of 2-3 mm and infrequently in the distal portion at 5-6 mm or more. They dichotomize in some regularity, producing zones of branching.

In the pyritized specimens the thecae are preserved in relief. The autothecae are the simple projecting tubes, numbering 10 in a length of 10 mm. The bithecae are hooked cross behind the autothecae and open in the side opposite their original side, belonging to the *Dictyonema flaciferum* type or *D. inconstans* type of Bulman.

Remarks: In the regular branching of the stipes this species bears a striking resemblance to *Callograptus salteri* Hall. On account of this character the writer has compared the present form with the latter species in 1953. But after

a careful study the writer noticed that there is a striking difference between them. In our species bithecae are strongly hooked. This is the oldest form which bears hooked bithecae so far as the writer's knowledge goes. This peculiar thecal character serves to distinguish this species easily from all other species of *Callograptus*.

Horizon and Locality: This species occurs in the *Callograptus? taitzeensis* zone of Yehli formation, Tien-shihfu, Liaoning in association with *Reticulograptus yangi* sp. nov. and *Callograptus sinicus* sp. nov. etc.

Cat. No. 7294-7296a-b (syntypes).

***Callograptus sinicus* sp. nov.**

(Pl. IV, figs. 8-11)

This species is represented by more than ten specimens. The rhabdosome is elongate, about 50 mm long and less than 20 mm wide, forming length/breadth ratio 2.5 : 1. At the proximal end of the rhabdosome is a large disc of attachment. The stipes are closely arranged, numbering 16 in a space of 10 mm transversally. They are slightly undulating, 0.25-0.3 mm in width, connected by a few dissepiments and separated by an interspace of nearly the same amount. The branching of the stipes is irregular, not forming branching zones.

The thecal character may be made out from the pyritized specimens. The autothecae are the long and projecting tubes. Thus some rows of pits are seen along the ventral side of the stipes. The bithecae are slightly curved, but not so strongly hooked as those in *Callograptus curvithecalis*. The bithecal apertures are curved inwards just behind the autothecae, belonging to the *Dictyonema cotyledon* type of Bulman.

Remarks: In regard to the general aspect of the rhabdosome this species stands nearest to *Callograptus salteri* Hall. After a careful comparing, the writer noticed that it differs from the latter species (1) in the elongate rhabdosome, (2) in the close arrangement and irregular branching of the stipes, and (3) in the character of thecae. The incomplete specimens of this species closely resembles *Callograptus curvithecalis* sp. nov., but differs therefrom in the less hooked bithecae and in the more slender and more irregularly branched stipes.

Horizon and Locality: Same as the preceding species.

Cat. No. 7297a-b—7299a-b (syntypes).

***Callograptus* sp. aff. *C. hopkinsoni* Bulman**

(Pl. IV, figs. 6-7)

Cf. 1875. *Callograptus salteri*, Hopkinson, Quart. Journ. Geol. Soc., Vol. 31, p. 667, Pl. 36, fig. 10.

Cf. 1932. *Callograptus hopkinsoni*, Bulman, Palaeontographical Soc., Vol. 86, pp. 84-86, textfig. 41, pl. 8, figs. 1-5.

Two incomplete specimens are referred to this species. One of them (Pl. IV, fig. 6) is composed of 7-8 parallel or subparallel stipes which are connected by a few fine dissepiments at right angles to the stipes and separated by interspace of much smaller width. The stipes are robust, about 0.9 mm in width, and gently flexuous in the distal part, numbering 7-10 in a space of 10 mm transversally. They branch at rather regular intervals of 3, 3, 6 mm etc. distally, producing zones of branching. The thecal character can not be observed due to ill preservation.

Remarks: This form recalls the British Ordovician species *Callograptus hopkinsoni* Bulman in the essential characters of the stipes, but the thecal character of our form is unknown. Thus the identification is only superficial.

Horizon and Locality: This species occurs in the zone of *Dendrograptus lotolatzensis* of the Yehli formation (Tremadocian) at Lotolatz, Penchi, Liaoning in association with *Dendrograptus lotolatzensis* sp. nov., *D. ptilograptoides* Mu, etc.

Cat. No. 7300a-b, 7301a-b (plesiotypes).

***Callograptus yangtzensis* sp. nov.**

(Pl. IV, figs. 3-5; textfig. 8)

The incomplete rhabdosome is 13 mm long and 8 mm wide. The stipes branch dichotomously at intervals



from 1 mm to 3 mm in the proximal portion of the rhabdosome and branch very infrequently in the distal. They are subparallel and gently undulating, only 0.35 mm wide in the dorsal view, but much broader (about 1 mm cross the thecal aperture) in the lateral view. The autothecae are the long and isolated tubes with a slight ventral curvature, numbering 16 in length of 10 mm. The bithecae are small, not so projecting as the autothecae. The dissepiments are infrequent and oblique in position, originating from the apertural part of the bithecae.

Remarks: At first glance this species resembles a species of *Desmograptus* in its undulating stipes, but no anastomosis is observed in the present form. In the dichotomous branching of the subparallel stipes, in the infrequent dissepiments and in the typical tubular thecae, this species is most probably belonging to *Callograptus*. In the isolated thecae it stands nearest to *Callograptus compactus* from the Utica shale of North America, but differs from the latter in the coarser stipes and in the more isolated thecae. The autothecae of the American species are nearly in contact. In the flexous stipes and the isolated thecae the present species closely resembles *Syrhipidograptus nathorsti* Poulsen from Denmark, but differs from the Danish form in the characters of the rhabdosome. The latter is characterized by the peculiar synrhabdosome and monomorphic thecae.

Horizon and Locality: This species occurs in the *Acanthograptus sinensis* zone of the Ichang formation (Tremadocian), Changyang, W. Hupeh in association with *Acanthograptus sinensis* Hsü, and *Dictyonema asiaticum* Hsü.

Cat. No. 7302 (holotype), 7303 (paratype).

### ***Callograptus? taitzehoensis* Mu**

(Pl. V, figs. 1-5)

1953. *Callograptus? taitzehoensis*, Mu, Acta Palaeontologica Sinica, Vol. I, No. 1, P. 34, Pl. 1, fig. 4.

The rhabdosome is conical in form, with a length of ca. 20 mm and a width of the same amount. It is attached with a short stem. The stipes are parallel, branching dichotomously at intervals of 3 mm in the proximal portion and at 6 mm in the distal, and producing zones of branching. The branches are 0.3-0.4 mm in width and separated by interspace more or less than 1 mm, numbering 10 in 10 mm transversally. The detail of the thecae is unknown, probably numbering 16 in 10 mm based on the complex impressions along the stipes. Dissepiment is entirely absent.

Remarks: In the mode of branching of the stipes and in the entire absence of dissepiments this species resembles *Bryograptus yentaiensis* sp. nov., but differs from the latter species in the much large size of the attached rhabdosome (the rhabdosome of *Bryograptus yentaiensis* is scutate). Morphologically, this species represents an intermediate form between *Callograptus* and *Dendrograptus*.

Horizon and Locality: It is the zone fossil of the *Callograptus? taitzehoensis* zone of Yehli formation, Taitze valley, Liaoning.

Cat. No. 7304a-b (holotype), 7305-7308 (paratypes).

### ***Callograptus? taitzehoensis* var. *minor* var. nov.**

(Pl. V, figs. 6-7)

This form is represented by very few specimens, the best of which is shown on plate V, figs. 6 & 7. It resembles *Callograptus? taitzehoensis* in the essential characters such as the parallel branches, the branching zones and the entire absence of dissepiments, etc., but differs therefrom only in the much smaller size of the rhabdosome. The thecal characters may be made out from a well preserved specimen. The autothecae are the simple and slender tubes, longer than the stolothecae, and the bithecae are much smaller. They are all straight and crowded together. There are 5 autothecae in a length of 3 mm.

Horizon and Locality: *Callograptus? taitzehoensis* zone of Yehli formation, Toufangkou, Penchi, Liaoning.

Cat. No. 7309a-b (holotype) 7310a-b (paratype).

### Genus *Aspidograptus* Bulman, 1934

#### *Aspidograptus* sp.

(Pl. III, fig. 8; textfig. 9)

The rhabdosome is very small, fan-shaped, about 9 mm in diameter. The main stipe is curved. From the convex side of this main stipe are given off the lateral branches which bifurcate again at intervals of 2 mm. Both the main and the lateral stipes have the same width of about 0.6 mm connected by a few very short dissepiments.

The thecae are short, closely arranged, numbering 4 in a length of 3 mm (i.e. about 13 in 10 mm). The autothecae and bithecae are difficultly distinguishable.

Remarks: In the general shape of the rhabdosome this form resembles *Aspidograptus? minor* Bulman and the proximal part of *Aspidograptus implicatus* (Hopkinson) of British Ordovician, but differs from the former in the greater width of the stipes and from the latter in the more loose arrangement of the thecae. From the North American species *Aspidograptus? parallelus* Ruedemann, the present form differs in the shape of rhabdosome and in the number of thecae in a given unit.

Horizon and Locality: This species occurs in the *Acanthograptus sinensis* zone of Ichang formation, Kantze-ping, Changyang, W. Hupeh.

Cat. No. 7311 (holotype).

### Subfamily Dendrograptinae Roemer, emend. Mu, 1953

(Including Ptilograptidae Hopkinson)

### Genus *Dendrograptus* Hall, 1858

#### CAMBRIAN SPECIES

#### *Dendrograptus* sp.

(Pl. V, fig. 8)

The rhabdosome is very small, with a height of 5 mm and a width of nearly the same amount. The stem or main stipe is probably thecate ("*Odontocaulis* condition") only 3 mm in length and 0.5 mm in breadth. From the distal end of the stem spread out two stipes, forming an angle of 90°. Both the stem and the stipes are similar in character, having a same width and a dorsal curvature. The character of the thecae is obscure due to the ill preservation.

Remarks: This primitive species is, so far as we know, the simplest form of *Dendrograptus*. In the shape of the rhabdosome it stands nearest to *Dendrograptus odontocauloides* Mu next described. But this form is more simple and much smaller. These two species apparently belong to a distinct group of *Dendrograptus*.

Horizon and Locality: This species occurs in the *Quadricephalus* zone of Upper Cambrian, Wutingshan, Yentai, Liaoning in association with *Dictyonema wutingshanense* sp. nov.

Cat. No. 7312 (holotype).

#### ORDOVICIAN SPECIES

#### *Dendrograptus odontocauloides* Mu

(Pl. V, fig. 12; textfig. 10)

1953. *Dendrograptus odontocauloides*, Mu, Acta Palaeontologica Sinica, Vol. I, No. 1, pp. 30, 35; Pl. I, fig. 3.

The rhabdosome is tree-like, bilaterally symmetrical, about 23 mm long and 17 mm wide. At the proximal end of the stem or the main stipe is a very small root-like basal process. The stem is thecate, i.e. in the "*Odontocaulis*



condition", measuring 10 mm in length and 0.6 mm in width. From the distal end of the stem spread out two stipes, forming an angle of 60°. These two stipes bifurcate again and again at intervals of 3.5 mm and at small angles. Both the stem and the stipes are similar in character.

The autothecae are cylindrical, denticulate in the lateral view, overlapping for 1/2–2/3 their length and numbering 7–8 in a length of 10 mm. The bithecae are obscure.

Remarks: The present species is one of the more regularly branched *Dendrograptus*. In the regular branching of the stipes this form bears some resemblance to a species of *Callograptus*, but differs therefrom in the separated stipes. By the peculiar form of the rhabdosome and the regular branching of the stipes this species may be easily distinguished from all other species of the genus *Dendrograptus*.

Horizon and Locality: This species occurs in the *Callograptus? taitzeensis* zone of Yehli formation (Tremadocian), Penchi, Liaoning in association with *Dictyonema uniforme*, *Callograptus? taitzeensis*, *Dendrograptus sinensis*, *D. suni*, *D. y-wangi*, etc.

Cat. No. 7313a-b (holotype).

### ***Dendrograptus sinensis* Mu**

(Pl. V, figs. 13-15)

1953. *Dendrograptus thomasi* var. *sinensis*, Mu, Acta Palaeontologica Sinica, Vol. 1, No. 1, Pl. 1, fig. 7.

The rhabdosome is bush-like, 17.5 mm in length and 15 mm in width. The proximal end of the rhabdosome is not seen. From the distal end of a short stem spread out two main stipes, forming an angle of ca. 60°. From both sides of the main stipes are given off at intervals of 2 mm the lateral stipes which may bifurcate again at small angles. Both the main and lateral stipes have the same width (0.25 mm) throughout and rigid in appearance. The autothecae are small tubes, overlapping for 1/2 their length. The bithecae are very small and occasionally observed. There are 16 autothecae in a length of 10 mm.

Remarks: This form closely resembles *Dendrograptus thomasi* Ruedemann from the Cambrian of North America in the shape of the rhabdosome, in the width of the stipes and in the arrangement of the thecae. Accordingly, in 1953 the writer was inclined to consider this form to be a new variety of the American species. But the Ruedemann's species occurs at a lower stratigraphical horizon (Upper Cambrian) than our form (Tremadocian) and its stipes are more flexuous and more closely set than ours. It seems best to regard our form as a distinct species.

Horizon and Locality: Same as the preceding species.

Cat. No. 7314a-b (holotype).

### ***Dendrograptus suni* sp. nov.**

(Pl. V, figs. 9-11)

The rhabdosome is tree-like, 22.5 mm in length and 8.5 mm in width. From a short stem originate two main stipes which bifurcate again and again both dichotomously and laterally at intervals of 3-5 mm and at angles of 30-40°. Both the main and the lateral stipes have the same width (0.6 mm) throughout. They are slightly flexuous and closely arranged, numbering 4-5 in a space of 5 mm transversally.

The autothecae are denticulate in the lateral view, numbering 8-9 in a length of 5 mm. The bithecae are the small and simple tubes.

Remarks: In the shape of the rhabdosome this species bears a striking resemblance to *Dendrograptus grabaui* Sun (especially to *Dendrograptus* cf. *grabaui* Sun), but differs from the latter in the more flexuous stipes. The stipes in that species are fairly straight throughout and rigid in appearance as pointed out by Prof. Sun (1935, p. 11).

Horizon and Locality: Same as the preceding species.

Cat. No. 7315a-b (holotype), 7316a-b (paratype)

***Dendrograptus y-wangi* sp. nov.**

(Pl. VI, figs. 1-3)

The rhabdosome is tree-shaped, 20 mm high and 15 mm wide. Two main stipes diverge from a short stem, forming an angle of  $50^\circ$ . Two or three simple or compound lateral stipes originate from the inner side of each main stipe at intervals of 2-3 mm and at more acute angles. Both the main and lateral stipes have same width, thinner (0.5 mm) in the dorsal view and slightly wider (0.6 mm) in the lateral view.

The autothecae are cylindrical and denticulate in the side view, numbering 5-6 in a length of 5 mm and overlapping for  $1/2$  their length. The bithecae are smaller and indistinct.

Remarks: In the flexuous stipes and the characters of the thecae the present species resembles *Dendrograptus suni* sp. nov. just described above, but differs from the latter in the shape of the rhabdosome and in the mode of branching of the stipes. In the shape of the rhabdosome this species bears some likeness to *Dendrograptus hallianus* (Prout) from the North American Cambrian, but differs from the American species in the flexuous stipes and in the character of the thecae.

Horizon and Locality: Same as the preceding species.

Cat. No. 7317a-b (holotype), 7318a-b 7319a-b (paratype).

***Dendrograptus liaotungensis* sp. nov.**

(Pl. VI, figs. 4-8)

This species is represented by several specimens. The rhabdosome is elongate, more than 30 mm in length and 10 mm in width. The stem is short and robust with a very small basal disc. The stipes are gently flexuous in the proximal portion of the rhabdosome and rigid in the distal. They are closely arranged, numbering 4-6 in a space of 5 mm transversally and having width of 0.5 mm in the dorsal view and 0.9 mm in the laterally preserved specimens. The thecae are denticulate in the laterally preserved stipes and steeply inclined, numbering 10 in a length of 5 mm. The autothecae and the bithecae are difficultly distinguishable.

Remarks: In the form of the rhabdosome this species resembles *Dendrograptus edwardsi* var. *major* Ruedemann of the North American Cambrian, but differs from the latter in the character of the thecae and in the more close arrangement of the stipes.

Horizon and Locality: This species occurs in the *Callograptus? taitzeensis* zone of the Yehli formation at Toufangkou, Penchi, and at Wutingshan Yentai, Liaoyang, Liaoning.

Cat. No. 7320-7324 (syntypes).

***Dendrograptus flexiramis* sp. nov.**

(Pl. VI, figs. 15-16)

This species is represented by two incomplete specimens. In one of them (Pl. VI, fig. 15) a short stem and a small basal disc are preserved. From the distal end of the stem originate two main flexuous stipes, forming an angle of  $60^\circ$ . The stipes are 0.3 mm in width and 12 mm in length. All the other stipes are broken away before the fossilization of this graptolite.

In the other specimen (Pl. VI, fig. 16) four flexuous stipes are observed. They are very thin (0.3 mm) in the dorsal view and broader (0.6 mm) in the lateral view, bifurcating at small angles and at irregular intervals. The autothecae are denticulate in the side view. The ventral margin of the autothecae is more concave and the apertural margin is even, forming thus a sharp apertural denticle. There are 9 autothecae in a length of 5 mm. The bithecae are obscure.

Remarks: In the thin and flexuous stipes the present species stands nearest to *Dendrograptus fluitans* Ruedemann from the Deepkill shale of North America, but differs from the latter species in the form of the rhabdosome



and in the characters of the thecae. The thecae (probably the autothecae) in the American species are more projecting and more loosely set.

Horizon and Locality: *Callograptus? taitzeoensis* zone of Yehli formation, Tien-shihfu, Liaoning.

Cat. No. 7325, 7326 (syntypes).

### ***Dendrograptus lotolatzensis* sp. nov.**

(Pl. VI, figs. 9-14)

This species is represented by more than twenty specimens. The rhabdosome is dendroid in form, very small. The largest specimen measures about 10 mm in length and 14 mm in width. It is composed of two or three main stipes from which the lateral stipes or branches originate. The branches are simple or bifurcating again at intervals of 1-3.5 mm. Both the main and lateral stipes are very thin, about 0.2 mm thick. The stem is usually short with a small disc of attachment at the proximal end.

The thecae cannot be seen in the dorsal view of the stipes. In the laterally preserved stipes the autothecae may be observed. They are short, denticulate, with a slightly convex ventral margin, numbering 14 in a length of 10 mm. The bithecae are unknown.

Remarks: In the shape of the rhabdosome this species resembles *Dendrograptus ontarioensis* Bassler of the Niagaran chert (Silurian), North America, but differs from the American species in the small thickness of the stipes and in the small size of the rhabdosome. In the thin stipes the present species bears resemblance to *Dendrograptus prae-gracilis* Spencer from the same formation of North America, but the shape of the rhabdosome and the character of the thecae are all different. In the small size of the rhabdosome this species stands nearest to *Dendrograptus yini*, sp. nov. described below, but differs from the latter in the more infrequent branching of the stipes.

Horizon and Locality: This species is preserved in an argillaceous dolomite of the basal part of the Yehli formation, 3 m above the top of the Hsiapingchou dolomite, at Lotolatz, Penchi, Liaoning in association with *Callograptus* sp. aff. *C. hopkinsoni* Bulman, *Dendrograptus ptilograptoides* Mu, etc.

Cat. No. 7327 (holotype), 7328-7332 (paratypes).

### ***Dendrograptus ptilograptoides* Mu**

(Pl. VII, fig. 13)

1953. *Dendrograptus ptilograptoides*, Mu, Acta Palaeontologica Sinica, Vol. 1, No. 1, pp. 30, 35; Pl. 1, fig. 6.

Only one more complete specimen is referred to this species. The rhabdosome is bush-shaped, 25 mm high and 15 mm in breadth. At the proximal end of the short stem seem to be a very small basal disc. The main stipe is slightly flexuous, branching laterally at irregular intervals and at small angles. The lateral stipes are simple or compound. Both the main and lateral stipes have same width of 0.45 mm.

The autothecae may be observed in the laterally preserved stipes. They are very small, denticulate, numbering 7-8 in a length of 5 mm. The bithecae are unknown.

Remarks: The characteristic feature of this species is that many lateral branches arise from the two sides of the main stipe. These lateral branches are more closely set in the distal part of the rhabdosome, forming a pinnate appearance. This peculiar character of our form can be easily distinguished from other species of *Dendrograptus*. In the arrangement of the lateral branches this species bears some resemblance to a species of *Ptilograptus*, but is not so regular as in that genus. The present form seems to unite features of *Dendrograptus* and of *Ptilograptus*. It is possible that this species represents probably a transitional form between the two genera. The specific name is based on the ptilograptid appearance of the rhabdosome.

Horizon and Locality: Same as the preceding species.

Cat. No. 7333a-b (holotype).

***Dendrograptus hsüi* sp. nov.**

(Pl. VII, figs. 1-4)

The rhabdosome is elongate, about 20 mm in height and 10 mm in breadth. It is composed of numerous very thin stipes, less than 0.2 mm in width. The stipes fall into several groups, arising alternately from the two sides of the flexuous main stipe. All the stipes bifurcate first at an angle of about 40°, and then turn inwards. The intervals between the branching of the stipes are commonly 1.3 mm or more.

The autothecae are the thin tubes very steeply inclined to the axis of the stipes, projecting a little and numbering 16-20 in 10 mm. The bithecae are very small, not projecting.

Remarks: This new species is characterized by the peculiar shape of the rhabdosome and the alternate groups of the stipes. The fragmentary specimens of this species bear some resemblance to *Dendrograptus lotolatzensis* sp. nov. from the Yehli formation, Liaoning and *Dendrograptus yini* sp. nov. from the Ichang formation, W. Hupeh. The present species may be distinguished from the former by the thinner stipes and the characters of the thecae, and from the latter by the slightly curved stipes and the smaller intervals between the branching of stipes.

Horizon and Locality: This species occurs in the upper part of *Acanthograptus sinensis* zone of Ichang formation (Tremadocian), Kaochialing, Changyang, W. Hupeh, in association with *Acanthograptus macilentus* Hsü, *Dendrograptus yangtzensis* sp. nov., *Dendrograptus yini* sp. nov., etc.

Cat. No. 7334 (holotype), 7335, 7336 (paratypes).

***Dendrograptus yangtzensis* sp. nov.**

(Pl. VII, figs. 5-10)

The present species is represented by several incomplete specimens. The rhabdosome is bush-shaped, elongate, more than 15 mm long and 10 mm wide. Two or more stipes spread from a short stem. One of them forms the flexuous main stipe from which the compound lateral branches originate. In the proximal portion of the rhabdosome the branching of the stipes is infrequent. Whereas in the distal part the stipes bifurcate quickly again and again, thereby producing numerous terminal branches. Both the main and the lateral stipes have the same width (0.3 mm). The terminal branches are more rigid in appearance than the main stipes.

The thecae are difficultly observed due to ill preservation. The thecal denticules may be occasionally seen, numbering 5 in a length of 2 mm. The autothecae and bithecae are not distinguishable.

Remarks: In the form of the rhabdosome this new species resembles *Dendrograptus hsüi* sp. nov., but differs therefrom in the more flexuous and irregular main stipes and in the greater width of the branches.

Horizon and Locality: Same as the preceding species.

Cat. No. 7337 (holotype), 7338-7342 (paratypes).

***Dendrograptus yini* sp. nov.**

(Pl. VII, figs. 11-12)

This new species is represented by several well preserved specimens including two complete rhabdosomes. The rhabdosome is very small, tree-like, usually 10 mm in length and same in width. From a short stem spread two or three main stipes. Each of them bifurcates into fourth or fifth order, thereby producing numerous stipes. All the stipes are very thin, thread-like, and rigid in appearance, bifurcating at angles of 30°. The interspaces between the branching of the stipes are 2 mm in the proximal portion of the rhabdosome and decrease into 1 mm in the distal. The thecae are the little projecting, numbering 10 in a length of 5 mm.

Remarks: In the small rhabdosome and in the thin stipes this new species stands nearest to *Dendrograptus*



*lotolatzensis* sp. nov. from the Yehli formation of the Taitzehe valley, but differs from the latter species in the more frequent branching of the more rigid stipes.

Horizon and Locality: Same as the preceding species.

Cat. No. 7343 (holotype), 7344 (paratype).

***Dendrograptus yini* var. *a***

(Pl. VIII, fig. 1)

This form recalls *Dendrograptus yini* sp. nov. in the essential characters, only differs from the latter in the thinner and more flexuous stipes.

Horizon and Locality: Ichang formation, Kantzeping, Changyang, W. Hupeh.

Cat. No. 7345 (holotype).

***Dendrograptus yini* var. *β***

(Pl. VIII, figs. 2-3)

This form resembles *Dendrograptus yini* in the essential characters, but differs therefrom in the smaller rhabdosome and more frequent branching of the stipes.

Horizon and Locality: Ichang formation, Tuopaossu, Changyang.

Cat. No. 7346 (holotype), 7347 (paratype).

***Dendrograptus hupehensis* sp. nov.**

(Pl. VIII, figs. 4-5)

The rhabdosome is very small, only 12 mm in length and 2 mm in width. It is composed of a main stipe and a few lateral stipes which originate from one side of the main stipe. Both the main and the lateral stipes are very thin, thread-like, less than 0.2 mm in width. The stipes are straight, bifurcating at a small angles of 20° or more and at rather long intervals of 1-3 mm. The thecae are long and slender, numbering 11 in 5 mm. The autothecae are steeply inclined to the axis of the stipe, slightly projecting and denticulate in the lateral view of the stipes. The bithecae are small, not projecting.

Remarks: In the very thin stipes and in the small angles of bifurcating this species resembles closely *Dendrograptus gracilimus* Ruedemann from the Deepkill formation of North America. But it differs from the American species in the infrequent branching of the stipes and in the loose arrangement of the thecae. From other small *Dendrograpti* this species may be easily distinguished by the shape of rhabdosome.

Horizon and Locality: *Acanthograptus sinensis* zone of Ichang formation, Kantzeping, Changyang, W. Hupeh.

Cat. No. 7348a-b (holotype).

**Genus *Ptilograptus* Hall, 1865**

***Ptilograptus glomeratus* var. *sinicus* var. nov.**

(Pl. VIII, figs. 6-8)

Two specimens are referred to the species. Of them one regarded as the holotype (Pl. VIII, figs. 6-7) is more complete. The rhabdosome is small about 15 mm in length and less than 10 mm in width. The main stipe bifurcates into two main stipes, forming an angle of 60°. All the main stipes bear lateral stipes alternately on two sides. The lateral stipes are parallel, 1-2.5 mm in length, inclined to the main stipes at 50-60°. There are 7 lateral stipes on each side of the main stipes in a length of 5 mm. Both the main and the lateral stipes are very thin, 0.2-0.3 mm in width. The main stipes are slightly broader than the lateral ones.

In the other specimen, the paratype (Pl. VIII, fig. 8), only one main stipe is preserved. The lateral stipes are short, only 0.8 mm in length, inclined to the main stipe at  $30-40^\circ$ , numbering 7 in a length of 5 mm. This represents probably only the distal part of a rhabdosome.

The thecae are not projecting, the detail of the thecal characters is unknown.

Remarks: This form stands nearest to *Ptilograptus glomeratus* Počta in the shape of the rhabdosome and in the mode of branching of the pinnate stipes, but differs from the latter in the more close arrangement of the lateral stipes. Unfortunately, the writer has not been able to obtain a description of *Ptilograptus glomeratus* Počta. The comparison is merely made from the figures reproduced by Bulman (1938, p. D19, figs. 13d-e).

Based on the pinnate arrangement of the stipes Hopkinson (1895) proposed the family Ptilograptidae for the genus *Ptilograptus*. The thecal character of *Ptilograptus* is similar to that in *Dendrograptus* as pointed by Ruedemann (1947), and in some forms of *Dendrograptus* such as *Dendrograptus ptilograptoides* sp. nov. described above the lateral stipes is somewhere arranged on both sides of the main stipes as the case in *Ptilograptus*. Therefore, the writer (1953) is of the opinion that it is better to regard the genus *Ptilograptus* as a member of the subfamily Dendrograptinae of Dendrograptidae than to regard it as a distinct family.

Horizon and Locality: This form occurs in the Neichiashan formation (Middle Ordovician) at Huayingshan, Szechuan in association with *Dictyonema szechuanense* sp. nov.

Cat. No. 7349 (holotype), 7350a-b (paratype).

### Family Acanthograptidae Bulman, 1938

#### Genus Acanthograptus Spencer, 1878

#### *Acanthograptus sinensis* Hsü

(Pl. VIII, fig. 14)

1948. *Acanthograptus sinensis*, Hsü, Contr. Inst. Geol., Vol. 8, pp. 13-14, pl. I, figs. 5a-b, 6a-b; Pl. II, figs. 1, 2a-b, 3, 5a-b.

Several fragmentary specimens are referred to this species. The stipes are robust, 1.5-2 mm in width exclusive of the twigs. The twigs are usually long, 1-1.5 mm in length, inclined to the stipes at  $50-75^\circ$ , numbering 11-13 in a space of 10 mm. For the detailed description of this species the reader is referred to Hsü's work (1948).

Horizon and Locality: The zone of *Acanthograptus sinensis* of Ichang formation (Tremadocian), Kantzeping, Changyang district, W. Hupeh.

Cat. No. 7351 a-b (plesiotype).

#### *Acanthograptus flexiramiatus* Hsü

(Pl. VIII, fig. 17)

1948. *Acanthograptus flexiramiatus*, Hsü, Contr. Inst. Geol., Vol. 8, pp. 17-18, Pl. IV, figs. 3a-b.

A fragmentary specimen is referred to this species. The stipe is slightly flexuous with a short lateral stipe, forming an angle of  $30^\circ$ . The width of the stipes is 0.8 mm exclusive of the twigs. The twigs are 0.8-1 mm in length, numbering 7-8 in a space of 5 mm.

Horizon and Locality: Same as the preceding species.

Cat. No. 7352a-b (plesiotype).

#### *Acanthograptus bifurcus* Hsü

(Pl. VIII, fig. 9)

1948. *Acanthograptus bifurcus*, Hsü, Contr. Inst. Geol., Vol. 8, pp. 16, Pl. III, figs. 2a-b, 3a-b.

One fragmentary specimen is identical with this species. The stipes are uniform in width, about 0.7 mm



exclusive of the twigs, branching dichotomously at an angle of  $70^{\circ}$ . The thecae are the long and slender tubes, grouping into short twigs. The twigs are spine-like, 0.5 mm in length, alternately arranged along the two sides of the stipes, numbering 7 in a space of 5 mm.

Horizon and Locality: Same as the preceding species.

Cat. No. 7353 (plesiotype).

### ***Acanthograptus macilentus* Hsü**

(Pl. VIII, figs. 10-13)

1948. *Acanthograptus macilentus*, Hsü, Contr. Inst. Geol. Vol. 8, pp. 15-16, Pl. II, figs. 4, 8a-b, 9a-b; Pl. III, figs. 1a-b.

The rhabdosome is small, usually 15-20 mm in length and 10 mm in width. It is composed of a main stipe and some lateral stipes which are given out from both sides of the main stipe at irregular intervals. Both the main and the lateral stipes are similar in characters, measuring 0.7 mm in thickness exclusive of the twigs. The twigs are 0.9 mm in length, numbering 6-7 in a length of 5 mm.

Horizon and Locality: Upper part of the *Acanthograptus sinensis* zone of Ichang formation, Kaochialing, Changyang, W. Hupeh.

Cat. No. 7354-7357 (plesiotypes).

### ***Acanthograptus rigidus* Hsü**

(Pl. VIII, figs. 15-16)

1948. *Acanthograptus rigidus*, Hsü, Contr. Inst. Geol., Vol. 8, pp. 18, Pl. IV, figs. 4a-b.

The rhabdosome is very small composed of one main stipe and several lateral stipes. Both the main and the lateral stipes are thin and rigid in appearance, uniformly 0.4 mm in width exclusive of the twigs. The twigs are short, 0.3-0.4 mm in length, numbering 5 in a length of 5 mm.

Horizon and Locality: Same as the preceding species.

Cat. No. 7358a-b, 7359a-b (plesiotypes).

### ***Acanthograptus flexilis* sp. nov.**

(Pl. IX, figs. 1-2)

This species is represented by several specimens. The rhabdosome is very small, more than 10 mm in length and less than 10 mm in width. It is composed of one strongly flexuous main stipe and some lateral stipes which originate from both sides of the main stipes at irregular intervals. Both the main and the lateral stipes are thin, 0.4-0.5 mm in width exclusive of the twigs. The twigs are long, 0.9 mm in length, numbering 9 in a length of 5 mm.

Remarks: In the small size of the rhabdosome and in the branching of the stipes this species resembles *Acanthograptus macilentus* Hsü and *A. rigidus* Hsü, but may be easily distinguished from those species by the strongly flexuous stipes and by the more close arrangement of the twigs.

Horizon and Locality: Ichang formation, Kaochialing and Kantzeping, Changyang.

Cat. No. 7360, 7361 (syntypes).

### ***Acanthograptus intermedius* sp. nov.**

(Pl. IX, fig. 3)

The rhabdosome is bush-shaped, very small, with a length of 10 mm and a breadth of nearly the same amount. The stipes spread from a very short stem at small angles. The median stipe bifurcate again and again both dichotomously and laterally. All the stipes are straight, rigid in appearance, having uniform width of 0.4 mm. They are slightly thinner in the ventral view. The twigs are 0.6 mm in length, numbering 5 in a length of 5 mm.

Remarks: In the small size of the rhabdosome and the small thickness of the stipes, this new species stands nearest to *Acanthograptus macilentus* and *A. rigidus*, but differs from those species in the form of the rhabdosome and in the mode of branching of the stipes. In the dichotomous branching of the stipes the present species bears some resemblance to *Acanthograptus bifurcus* Hsü, but differs strikingly in the smaller rhabdosome and in the thinner and more rigid stipes.

Horizon and Locality: Upper part of *Acanthograptus sinensis* zone of the Ichang formation, Kaochialing, Changyang district, W. Hupeh.

Cat. No. 7362 (holotype).

### Genus *Coremagraptus* Bulman, 1927

#### *Coremagraptus?* sp.

(Pl. IX, fig. 4)

The present form is represented by a single specimen and the counterpart. No complete rhabdosome is known. The incomplete specimen is very small, 6 mm long and 3.5 mm wide. The stipes are flexuous, zigzag in detail, having a width of 0.3–0.4 mm exclusive of the twigs. They seem to be occasionally united by anastomosis(?). The twigs are little projecting, numbering 5–7 in a length of 5 mm. The branching of the stipes is mainly lateral, and occasionally dichotomous in the distal portion of the rhabdosome. The characters of the thecae are similar to those of the genus *Acanthograptus*.

Remarks: This form resembles a species of *Acanthograptus* in the general aspect of the twigs, but differs in having undulating stipes. In the undulating stipes and in the probable presence of anastomosis this species recalls a species of *Coremagraptus*. Since the specimen is too fragmentary to make a definite determination, it is preferable to put a query-mark after the generic name *Coremagraptus*.

Horizon and Locality: The zone of *Acanthograptus sinensis* of Ichang formation, Kantzeping, Changyang, W. Hupeh.

Cat. No. 7363a-b (holotype).

### Family Inocaulidae Ruedemann, 1947

#### Genus *Inocaulis* Hall, 1851

#### *Inocaulis sinicus* sp. nov.

(Pl. IX, fig. 5)

The rhabdosome is composed of only one straight stipe, 14 mm in length and 0.5 mm in width exclusive of the projecting thecal tubes. The stipe is narrow in the proximal part, becoming wider and wider distally. Near the distal end the maximum width (0.5 mm) is obtained. The thecal tubes are long, very fine, but stiff, projecting out at angle of 20°.

Remarks: In the projecting thecal tubes this form bears likeness to a species of *Acanthograptus*, but the thecal tubes in this form are all free distally, not grouped into the twigs as those in *Acanthograptus*. The peculiar form of the rhabdosome and the distinct stiff thecal tubes of our species can be distinguished from other species of *Inocaulis*.

Horizon and Locality: *Dendrograptus lotolatzensis* zone of Yehli formation (Tremadocian), lotolatze, Penchi, Liaoning.

Cat. No. 7364 (holotype).

#### *Inocaulis?* sp. A.

(Pl. IX, figs. 8–9)

The rhabdosome is elongate, about 30 mm in length only a few millimeters in width, consisting of several



flexuous stipes. The stipes bifurcate at very small angles and at relatively long intervals. All the stipes are uniform in width (about 1.4 mm) with smooth and parallel sides. The traces of the thecal tubes may be occasionally seen along the stipes. They are parallel and crowded in arrangement, not projecting. The detailed character of the thecae is unknown.

Remarks: In the shape of the rhabdosome the present form resembles closely *Inocaulis simplex* Ruedemann of the North American Ordovician. The thecal tubes are slightly projecting in the American species, but not so in our form.

Horizon and Locality: *Callograptus? taitzehoensis* zone of Yehli formation, Tienshihfu, Liaoning.

Cat. No. 7365 (holotype), 7366 (paratype).

***Inocaulis? sp. B.***

(Pl. IX, figs. 6-7)

This species resembles the preceding one in the essential characters, but differs therefrom in the dichotomous branching of the more rigid stipes.

Horizon and Locality: Yehli formation, Wutingshan, Yentai of Liaoyang district and Tienshihfu of Penchi district, Liaoning.

Cat. No. 7367 (holotype), 7368 (paratype).

**Family Anisograptidae Bulman, 1950**

**Genus *Anisograptus* Ruedemann, 1937**

***Anisograptus lui* Mu**

(Pl. IX, figs. 14-15)

1953. *Anisograptus lui*, Mu, Acta Palaeontologica Sinica, Vol. I, No. 1, pp. 30, 35; Pl. I, fig. 5.

This species is represented by several specimens including one incomplete rhabdosome and some fragmentary stipes. The rhabdosome is horizontal, 80 mm in diameter, composed of about two dozen terminal stipes. From the central triate "funicle" where is a small peak indicating the position of the sicula diverge three short primary stipes (1 mm in length). Each of the primary stipes dichotomously branches into two stipes of the second order, being 2.5 mm in length and 1.2 mm in width. All the stipes of the second order dichotomously branch again and again. The stipes of the third order are equal in width (1 mm) but not equal in length. They fall into two groups of which one is 3 mm in length and the other is 6.5 mm. The fourth order stipes of the two groups are 7.5 mm and 8 mm in length, and the fifth order stipes are 9 mm and more than 10 mm respectively. All the stipes spread out horizontally with a gentle curvature.

From the laterally preserved stipes of the other specimen (Pl. IX, fig. 15) the writer is able to make out the characters of the thecae as follows:

The autothecae are very long and slender. They are very steeply inclined to the general trend of the stipe. The length of the autothecae is 1.2 mm, about 4 times as long as wide, overlapping for  $2/3-3/4$  their length and numbering 12-13 in a length of 10 mm. The bithecae are also the simple tubes but much smaller.

Remarks: In the shape of the rhabdosome and in the mode of branching of the stipes this species stands nearest to *Anisograptus richardsoni* (Bulman, 1941, pl. II, fig. 6), but differs therefrom in the larger rhabdosome and in the shorter primary stipes. At first sight, this species bears a striking resemblance to *Clonograptus tenellus* var. *calavei* (Elles et Wood, 1902, Pl. II, figs. 3a-b), a closer examination shows that it differs from the latter in having three primary stipes, one of the characteristic features of the genus *Anisograptus*.

Horizon and Locality: This species occurs in the *Callograptus? taitzeensis* zone of the Yehli formation (Tremadocian), Wutingshan, Yentai, Liaoning in association with *Dictyonema flexiliramosum* sp. nov., *Bryograptus yentaiensis* sp. nov., etc.

Cat. No. 7369a-b (holotype), 7370 (paratype).

***Anisograptus* cf. *matanensis tetragraptoides* Bulman**

(Pl. IX, fig. 16; textfig. 13)

Cf. 1950. *Anisograptus matanensis* var. *tetragraptoides*, Bulman, Quart. Journ. Geol. Soc. London, Vol. 106, pp. 83-84, pl. 7, figs. 14-17; pl. 8, figs. 4, 11; Textfig. 4h.

The rhabdosome is tri-radiate, horizontal, very small, 10 mm in diameter. It is composed of four stipes, bearing a superficial resemblance to a species of *Tetragraptus*. Three primary stipes radiate from the sicula. One of them bifurcates at a short distance (slightly more than 1 mm) into two stipes of the second order, and the other two remain undivided throughout. Both the primary and secondary stipes spread out horizontally, having a width of 0.4 mm. They are straight and rigid in appearance, but no profile is visible. Only indications of the thecae (probably the autothecae) may be observed along the stipes, numbering 5-6 in a length of 5 mm.

Remarks: Apart from the small size of the rhabdosome the present form is identical with *Anisograptus matanensis* var. *tetragraptoides* Bulman of the Matane shale (Tremadocian), Canada in all other characters. This specimen may be an incomplete rhabdosome if not an immature. In the general aspect of the rhabdosome it recalls a species of *Tetragraptus*, but differs therefrom strikingly in the tri-radiate stipes.

Horizon and Locality: This form occurs in the *Clonograptus-Triarthrus* zone of the Yinchupu shale (Tremadocian), Kiangshan, W. Chekiang in association with *Clonograptus tenellus* var. *calavei* Elles et Wood, *Adelograptus asiaticus* sp. nov. and *Didymograptus?*

Cat. No. 7371a-b (plesiotype).

**Genus *Bryograptus* Lapworth, 1880, emend. Bulman, 1941**

***Bryograptus yentaiensis* sp. nov.**

(Pl. IX, figs. 17-18)

This new species is represented by two specimens of which one is rather complete. The rhabdosome is pendent, very small, with an axial length of 9 mm and a greatest width of 7 mm near the distal end. Three main stipes dichotomously branch thrice or more at intervals of about 2 mm, forming zones of branching. All the stipes are very thin, thread-like, about 0.2 mm in thickness. They are subparallel and slightly flexuous, numbering 11 in a space of 5 mm transversally in the distal portion of the rhabdosome. The autothecae are slender and little projecting, numbering 9 in a length of 5 mm. The bithecae are present but obscure, only pits may be observed along the stipes.

The foregoing description is based on the holotype (Pl. IX, fig. 17). In the other specimen, the paratype (Pl. IX, fig. 18), the sicula is more conspicuous. It is considerably long, nearly 1 mm in length. On the apex of the sicula is situated a very small floating visicle which is only 0.5 mm in diameter. From the sicula spread three primary stipes pendently. One of them is not preserved.

Remarks: In the shape of the rhabdosome and in the mode of branching of the stipes this species stands nearest to *Bryograptus patens* Matthew of the Matane shale, Canada (Bulman, 1950), but differs from the Canadian species in the much smaller size of the rhabdosome. In the regular branching and close arrangement of the subparallel stipes this species bears some resemblance to *Callograptus? taitzeensis* Mu, but differs from the latter in the pendent and siculate rhabdosome.

The genus *Bryograptus* was formerly regarded as a member of Graptoloidea. In 1950 Bulman transferred this



genus from the Order Graptoloidea into the Order Dendroidea on account of the prevalence of Dendroid branch-structure. But whether the type species of this genus, *Bryograptus kjerulfi* Lapworth, is a Dendroidea or a Graptoloidea is still an open question. Our species *Bryograptus yentaiensis* sp. nov. together with *Bryograptus patens* Matthew and *Bryograptus chekiangensis* sp. nov. next described seems doubtless the members of Dendroidea. If the genotype of *Bryograptus* is a true Graptoloidea, these forms must represent a new genus belonging to the Dendroidea.

Horizon and Locality: Zone of *Callograptus? taitzeensis* of the Yehli formation, Wutingshan, Yentai, Liaoyang, Liaoning.

Cat. No. 7372 (holotype), 7373 (paratype).

### ***Bryograptus chekiangensis* sp. nov.**

(Pl. X, figs. 1-3)

The rhabdosome is pendent, median in size, about 27 mm in length and 12 mm in width. The stipes are thin, 0.4 mm wide, bifurcating dichotomously at regular intervals of 5-10 mm and producing the branching zones. The thecae are obscure due to poor preservation. Only the traces of the slender thecal tubes may be observed.

Remarks: In the mode of branching of the stipes this species strongly resembles *Bryograptus yentaiensis* sp. nov. just described above and *Bryograptus patens* Matthew from Canada, but differs from those forms in the size and shape of the rhabdosome. In the general aspect this form recalls *Dictyonema flabelliforme* var. *bryograptoides* Bulman of the *Dictyonema* shales (Tremadocian) Norway, but no distinct dissepiment is observed in the present species. It is most probable that this new species is a derivative of *Dictyonema* due to the atrophy of the dissepiments.

Horizon and Locality: This species occurs in *Clonograptus-Triarthrus* zone of the Yinchupu shale, Kiangshan, W. Chekiang, in association with *Adelograptus sinicus* sp. nov. and *Didymograptus?*

Cat. No. 7374 (holotype).

### ***Bryograptus? shengi* sp. nov.**

(Pl. IX, figs. 10-13)

The rhabdosome is very small, bell-like, with a length of 6.5 mm and a width of 5.5 mm. From the proximal end of the rhabdosome three primary stipes diverge pendently, becoming parallel to each other in the great part. Each main stipe bears two or three lateral stipes which are simple or compound. Both the main and the lateral stipes are very thin, about 0.2 mm in width. They are closely arranged, numbering 9-10 in a space of 5 mm transversally.

The foregoing description is based on the holotype (Pl. IX, figs. 10-11), while in the other specimen, the paratype (Pl. IX, figs. 12-13), the sicula is distinctly observed. At the apex of the sicula is a very small but complex floating vesicle or disc of attachment. The first thecae seems originated from the apical portion of the sicula, probably the prosicula. Based on a laterally preserved stipe in this specimen, the following thecal characters are made out.

The autothecae are small, denticulate in the profile. The ventral margin of the autothecae is convex and the apertural margin is concave, forming thus sharp apertural denticles. They overlap for 1/2 their length or more, numbering 8-9 in a length of 5 mm. The bithecae are present, but obscure due to the ill preservation.

Remarks: This species stands nearest to the specimens described by Elles and Wood as *Bryograptus kjerulfi* Lapworth from the British Tremadocian in the shape and size of the rhabdosome, but differs from the British species in the more close arrangement of the thecae and in the much smaller thickness of the stipes. In the complex structure of the proximal end of the rhabdosome and the close arrangement of the stipes, the present form recalls a species of

*Dictyonema*, but no distinct dissepiment is observed in this species. The generic determination of the present new species is thus uncertain, until more complete and well preserved specimens are available.

Horizon and Locality: Yehli formation, Shanchengtze, Penchi, Liaoning.

Cat. No. 7375a-b (holotype), 7376a-b (paratype).

### Genus *Clonograptus* Hall et Nicholson, 1873

#### *Clonograptus tenellus* var. *calavei* Elles et Wood

(Pl. X, figs. 9-13; textfig. 14)

1902. *Clonograptus tenellus* var. *calavei*, Elles and Wood, Monogr. British graptolites, Pal. Soc. London, Pt. II, p. 84, Pl. XI, figs. 3a-c.  
 1909. *Clonograptus tenellus* var. *calavei*, Westergaard, Lunds Univ. Ars. II, [5] 3, p. 69, Pl. IV, figs. 1-13; Pl. V, fig. 2.  
 1922. *Clonograptus tenellus* var. *calavei*, Poulsen, Danmarks Geol. Unders. IV, [1], 16, p. 11, figs. 7-9.  
 1925. *Clonograptus tenellus* var. *calavei*, Monsen, Norsk Geol. Tids., VIII, p. 158, Pl. I, figs. 4-6.

The rhabdosome is horizontal, bilaterally symmetrical, about 55 mm in diameter. From the sicula originate two short and thick primary stipes which dichotomously branch again and again into the 5th order, producing more than 24 terminal stipes. The intervals between the branching of the stipes gradually increase distally. All the stipes are horizontal and somewhat rigid in appearance, about 0.8 mm in width. It is a fact that our specimens are more or less deformed due to compression. In the obliquely compressed specimen (Pl. X, figs. 10-12) the intervals between the branching of the stipes seem to be irregular in appearance, whereas in the laterally compressed specimen (Pl. X, fig. 9) they are in some regularity.

Since the stipes grow horizontally and usually preserved in the dorsal view, the thecae are difficultly observed. In the lateral-dorsal view of the terminal stipes the thecae may be occasionally seen. They are long and slender with a very sharp thecal denticle. In the associated fragmentary stipes probably belonging to the same form the true profile of the thecae may be observed. The autothecae are denticulate with a very sharp denticle, numbering 10 in a length of 10 mm. The bithecae are present, but obscure.

Remarks: This form is identical with *Clonograptus tenellus* var. *calavei* Elles et Wood in essential characters, but differs slightly in the closer arrangement of the thecae. In the form of the rhabdosome the present form bears a striking resemblance to *Clonograptus flexilis* (Hall), and *C. rigidus* (Hall) of North America, but the characters of the thecae are different.

Like *Bryograptus*, the genus *Clonograptus* was formerly regarded with a little doubt as a member of Graptoloidea and transferred by Bulman into the Order Dendroidea in 1950. Similarly, whether the genotype of this genus (*Graptolithus rigidus* Hall) is a Dendroidea or a Graptoloidea is also uncertain. But *Clonograptus tenellus* var. *calavei* Elles et Wood is apparently a Dendroid graptolite.

The present form is a very common graptolite in the Tremadocian of British Isles and Sweden where no *Anisograptus* is recorded. It has not yet been found in Norway and the eastern part of North America where the anisograptids are abundant. It is of interest to note that the occurrence of this form in association with *Anisograptus* in Chekiang, China indicates a peculiar graptolite fauna belonging to a different graptolite province.

Horizon and Locality: This form occurs in the *Clonograptus-Triarthrus* zone of the Yinchupu Shale (Tremadocian), Kiangshan, W. Chekiang in association with *Anisograptus* cf. *matanensis* var. *tetragraptoides* Bulman, *Adelograptus asiaticus* sp. nov. and *Didymograptus*?. The present form has been also recorded by Prof. Hsü from the Tanchiachiao series (Tremadocian) of southern Anhwei (Bull. Geol. Soc. China, Vol. 15, p. 105).

Cat. No. 7377-7379 (plesiotype).



**Genus *Adelograptus* Bulman, 1941*****Adelograptus asiaticus* sp. nov.**

(Pl. X, figs. 4-7)

This species is represented by several incomplete specimens. No complete rhabdosome is known, but from the portion preserved there is little doubt that the rhabdosome is declined to pendent. The rhabdosome is small with a length of 4.5 mm and a breadth of nearly the same amount. The sicula is distinct, about 1 mm in length and 0.4 mm in breadth. Two primary stipes diverge from the proximal portion of the sicula at an angle of  $90^\circ$ . Each of them bears simple or compound lateral stipes which are similar to the main stipe in the essential characters. The stipes measure 0.6 mm in width across the thecal apertures in the side view, but much narrower (0.2-0.3 mm) in the dorsal view.

The thecae (probably the autothecae) are about 1 mm long and three times as long as wide. The ventral margin is concave and the apertural margin is straight, forming thus a sharp thecal denticle. The thecae overlap for about  $1/2$  their length, numbering 7 in a length of 5 mm. The bithecae and the stolothecae are not recognized.

Remarks: In regard to the mode of branching of the stipes this species stands nearest to the genotype of *Adelograptus*, *Bryograptus*? *hunnebergensis* Moberg, but in the latter species the stipes are nearly horizontal and the thecae are more loosely arranged. In the general aspect of the rhabdosome the present species bears a striking resemblance to *Adelograptus victoriae* T. S. Hall from the Lancefield beds (Tremadocian) of Australia, but differs from the Australian species in the more robust stipes.

Horizon and Locality: This new species occurs in the *Clonograptus-Triarthrus* zone of the Yinchupu shale at Nanchiao, Kiangshan, western Chekiang in association with *Clonograptus tenellus* var. *calavei* Elles et Wood, *Anisograptus* cf. *matanensis* var. *tetragraptoides* Bulman, *Didymograptus*?, etc.

Cat. No. 7380 (holotype), 7381-7383 (paratypes).

***Adelograptus sinicus* sp. nov.**

(Pl. X, fig. 8)

The rhabdosome is declined with a very distinct sicula which is very narrow and relatively long about 1.3 mm in length and less than 0.3 mm in breadth. Two primary or main stipes diverge from the middle part of the sicula at an angle of  $110^\circ$ . One of them is only partly preserved, while the other bears a lateral stipe on the ventral side. The stipes are very thin, about 0.3 mm in width in the lateral view.

The thecae are long and slender, about 1.7 mm in length and 6-7 times as long as wide, and are very steeply inclined to the trend of the stipe. Both the ventral and the apertural margins of the thecae are concave, forming thus a very sharp denticle. The thecae overlap for  $1/3$  their length, numbering 4-5 in a length of 5 mm.

Remarks: In the general aspect of the rhabdosome the present species closely resembles *Adelograptus divergens* (Elles et Wood) from the British Tremadocian, but differs from the latter strikingly in the characters of the thecae. In our species the stipes are thinner and the thecae are longer than those in the British form. These characters of the present species can be also distinguished from *Adelograptus asiaticus* sp. nov. just described above, *Adelograptus hunnebergensis* (Moberg) of Europe and *Adelograptus victoriae* T. S. Hall of Australia.

From Deskill shale (Arenigian) of North America, Ruedemann described some species under the generic name *Bryograptus*, namely *Bryograptus lapworthi* Ruedemann, *B. kırkı* Ruedemann, *B. pusellus* Ruedemann, etc. The presence of only two primary stipes in these species reveals that they are not the members of *Bryograptus* which has three primary stipes. These forms obviously belong to *Adelograptus*, if they are true Dendroidea. All these American species may be distinguished from our new species *Adelograptus sinicus* by the shape of the rhabdosome alone.



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It is of interest to note that in the form of the rhabdosome and in the dichotomous branching of the stipes *Adelograptus kirki* (Ruedemann) and *Adelograptus lapworthi* (Ruedemann) strikingly resembles an Australian species described by Harris and Thomas as *Zygograptus irregularis* from the Chewtorian (Arenigian). They are related to if not generically identical with each other. It is not impossible that the Tremadocian species of the so-called "Graptodendroids", such as *Anisograptus*, *Bryograptus*, *Triograptus*, *Adelograptus* and *Conograptus*, are the Dendroidea, whereas the Arenigian or later forms referred to these genera are most probably belonging to Graptoloidea.

Horizon and Locality: *Adelograptus sinicus* sp. nov. occurs in the *Clonograptus-Triarthrus* zone of the Yinchupu shale (Tremadocian) at Huangnikang, Kiangshan district of western Chekiang in association with *Bryograptus chekiangensis* sp. nov., *Didymograptus*, etc.

Cat. No. 7384 (holotype).



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